A REPORT

OF A

SANITARY TOUR.

To the Under Secretary of State for India.

From Surgeon T. G. Hewlett, Health Officer of Bombay.

Sir,

I have the honour to report to you, for the information of the Secretary of State for India, that in accordance with the permission granted to me in your letter, dated June 3rd, 1869, I have visited the Towns marginally noted with the view of inspecting works of Main Sewerage, Water Supply, and Sewage Irrigation.

Banbury
Warwick
Coventry
Rugby
Bedford
Leicester
Birmingham
Liverpool
Wigan
Preston
Blackburn
Manchester
Bradford
Leeds
Lancaster
Penrith
Carlisle
Hexham
Sunderland
Tynemouth
Alnwick
Berwick on Tweed
Edinburgh
Glasgow
Swansea
Portsmouth
Worthing
Hastings
Dover
Croydon

These Towns embrace the following classes—

1st.—Those situate in purely agricultural districts, such as Banbury, Warwick, Rugby, Bedford, &c.

2nd.—Inland centres of Manufacture, such as Birmingham, Manchester, Leeds, &c.

3rd.—Seaport Towns, such as Liverpool, Glasgow, Swansea, Portsmouth, &c.

The moral, physical, and economical conditions in each class vary, and had I proposed to have undertaken a statistical and special enquiry, embracing all the causes that affect the Sanitary standard of each particular Town, such conditions would have had to be specially considered and reported upon; but such an analysis would have necessitated a long residence in each place, and would have been beyond the scope of the present enquiry.

It therefore appeared to me desirable to trust to the Local Authorities for a description of the various

works and facts relating to Sanitation in each particular Town, and I accordingly append statements which have been compiled from extracts from reports and from information given me by Local Authorities.

I can never be sufficiently grateful for the kindness which Mr. Rawlinson's introduction ensured me at most of the Towns under report, or for the very liberal manner in which I have been supplied with printed reports, plans, maps, etc., etc.

My especial thanks are due to Mr. Newlands, the Borough Engineer of Liverpool, who furnished me with copies of his own and Dr. Trench's reports, besides those on all other matters concerning the Municipal Administration of that City.

I am also much indebted to Mr. Till and Mr. Gray of Birmingham, to Mr. Filliter of Leeds, to Dr. Little and Mr. Lynde, of Manchester, to Mr. MacPherson of Edinburgh, who gave me Dr. Littlejohn's admirable report on the Sanitary state of that City, to Mr. Carrick and in an especial manner to Dr. Gairdner of Glasgow, whose reports are particularly valuable, to Mr. Cousins and Dr. Davies of Swansea, to Mr. Latham of Croydon, as well as to other gentlemen with whom I was brought in contact.

The literature pertaining to Sanitation, embodying the varied experiences of all the most skilful Engineers and Officers of Health in the United Kingdom, would be of incalculably greater value if it were more easily obtainable, and it seems to me to be a matter of regret that all such reports are not forwarded to a central office for distribution not only to other Towns in the Kingdom but to the Colonies, as at present they are beyond the reach of the public, being only circulated among the members of the particular Municipality to which they refer.

In this sketch I shall confine myself to summarizing those lessons I have learnt which appear to me to be

more especially applicable to India, and shall venture to make suggestions regarding those points which seem to me might be advantageously entertained for adoption in India.

I would premise, however, lest it should be thought that I at all depart from matters more immediately connected with my profession in giving an opinion as to certain details of Sanitary Engineering that I would ask for indulgence on the plea that as the origin of certain diseases is undoubtedly to be traced to the faulty construction of Works of Sewerage, etc., I, as a Health Officer, must be necessarily interested in seeing, and should fail in my duty if I did not see, that all those avenues through which, in my opinion, disease may be entailed on a people committed to my charge are efficiently defended in the only way I believe they possibly can be, in the introduction of those works which, if constructed on true hygienic and common sense principles, are among the greatest blessings engineering science has conferred upon communities, but which prove the entire reverse if the principles I allude to are neglected.

Viewing then the question of Sanitary Engineering as a border land in which Engineers and Officers of Health are both equally interested, and in which they may both freely express their opinions, I would state my conviction that any system must fail if it is not *universally* adopted in the inhabited place to which it is applied.

In Manchester, Liverpool, Birmingham, etc., only a portion of the houses are fitted with water-closets. In the remainder, and in Manchester, (where the Corporation discourages their use,) in the larger portion there are middensteads, or receptacles both for nightsoil and ashes, which are in my opinion doubly objectionable, as they have to be periodically cleaned at a great expense; but as they necessarily entail the accumulation of nightsoil in the vicinity of human habitations, are sources of danger, however carefully constructed or ventilated they may be.

As far as I can see, water-carriage appears to be, under existing circumstances, the most convenient vehicle for the removal of all refuse from large Towns in England.

This system has not yet been tried in India, and it remains to be seen whether it is the one best suited to the local habits of the people,* and whether a sufficient supply of water can be provided to carry the sewage to its outfall before decomposition has set in.

I will not in this paper discuss the question, whether in India it would not be better to exclude nightsoil altogether from the sewers, but, on the supposition that both the above conditions are fulfilled and that a general water-closet system has been determined upon, I hold that works of Main Sewerage to be effective should essentially embrace the following points, which have been so concisely expressed by Mr. Newlands, the Borough Engineer of Liverpool, in his Report of 1848, that I copy them from it,—

First.—The removal in covered conduits from the houses (Mr. Newlands adds "and of streets" but this I object to) of all refuse capable of suspension or solution in water, as fast as it is produced, in such a manner as shall prevent the generation of noxious gases.

Secondly.—The perfect underground drainage of the whole strata to such a depth as will keep the lowest parts of the buildings free from damp.

Thirdly.—The disposal of the refuse so that it may not pollute the natural drainage outlets, the streams or rivers in the vicinity, or vitiate the atmosphere, but may be applied to the legitimate use of increasing the fertility of the surrounding country.

The first condition, especially in a country like India where the rain only falls during certain months of the year, would, in my opinion, be best attained by the adoption of the separate system and by a strict observance of the rule that sewers should invariably be laid in straight lines, and be only of a size sufficient to remove the sewage matter, whilst the rainfall should be allowed to flow away into its natural channels.

* Since the above was written, I have heard from Dr. Sutherland, that an apparatus suitable for the manners and customs of Oriental races has been contrived by an Officer of the Royal Engineers, who has had great experience of the requirements of the natives in Turkey, and that the Turks are now introducing drainage, and similar latrines on their own account.

The success of such an apparatus would remove *one* of the objections to a water-closet system for India

The towns sewered under the direction of Mr. Rawlinson attracted my immediate attention by the observance of the common-sense rule of sewers laid in straight lines.

The introduction of stoneware or earthenware pipes as channels for the conveyance of sewage matter has effected a complete revolution in Sanitary Engineering, and I am fully satisfied that immense good would result if Government was pleased to send out to India men competent to instruct the natives in the manufacture of them.

While leaving the main sewers to be laid by the Engineer, I think that the Health Officer should still see that at their points of connection with inhabited houses no danger to health is likely to accrue.

The mode of laying the subordinate sewers which seems to me to be best, is the common-sense one which obtains at Swansea, and which from the existence of sweepers' passages would be peculiarly adapted to Bombay.

This, to quote from the Report of Mr. Davies, the able Medical Officer of Health of Swansea, is carried out as follows :—" Houses are not drained directly into the main sewer but into subordinate sewers at the rear of houses on both sides of the street. The sewers are easy of access, and the drainage of back premises is not carried under the houses. Each house is connected independently with the subordinate sewer, which is finally connected with the main."

Perfect ventilation of all the sewers is essentially necessary. I have seen many methods adopted to effect this most difficult but all important question. Either as Mr. Rawlinson always orders with so much success—to quote again from Dr. Davies—" by ventilating shafts in connection with every manhole along the course of the main sewer, at an average distance of 40 yards from each other, each ventilating shaft being fitted with trays filled with finely broken vegetable charcoal through which the gases must pass before they escape into the street."

I would here remark that some Engineers, especially

in Manufacturing Towns where there is a great escape of steam into the sewers, object to the use of charcoal for the reasons given by Mr. Newlands in his evidence before the Liverpool Mortality Sub-Committee, published in 1866, page 56, where he says "Charcoal in the concrete state is a very good condenser of gas, but I have always found it fail when brought into contact with watery vapour, as when it is put over a sewer. The action of the charcoal is mechanical—it acts as a sponge, and as its affinity for watery vapour is greater than for any gas it does not act so well as a deodorant in damp as in dry situations."

I was shewn however at Croydon, by Mr. Baldwin Latham, a charcoal ventilator lately invented by himself, which from its mechanical ingenuity will, I think, prove to be perfectly successful in its action, as all danger of the charcoal being in any degree wetted is entirely prevented.

At Liverpool and other towns the rain-water spouts, where the tops open above the level of the highest windows, are used to ventilate the sewers.

I cannot but think such a method is a hazardous one, though Mr. Newlands, whose great experience of course is extremely valuable, thinks they are safe; yet I do believe that in certain conditions of the atmosphere the sewer gases would be likely to be brought down into the sleeping apartments, and that therefore this method should not be adopted.

In Liverpool, Mr. Newlands has used for the last 18 years, and has lately greatly extended the introdution of the Archimedean Screw Ventilator. This consists of a pipe carried from the top of sewers to the summit of any high building adjoining; the pipe terminating in the Archimedean Screw Ventilator; and he proposes to apply these at the dead ends of sewers and where sewers and drains change their direction and gradient.

This invention appears to me likely to be of infinite use in India, not only for ventilating sewers but also

buildings, as it ensures a rapid exhaustion of the air below, and will act incessantly whenever there is, as in Bombay, a continuous current of air.

Ventilation by the connection of sewers with furnaces would be applicable in but a very few places in India.

The flushing of Sewers is effected in various ways—both by flushing chambers over the line of sewers filled by connections with the water mains; by self-acting tumbler receptacles, as at Swansea and at Leicester; by a moveable flushing tank, capable of holding upwards of 1,000 gallons of water which is suddenly discharged into the sewer. All of which methods are applicable to India.

Regarding the sanitary defences requisite to protect the interior of houses from the entrance of sewage gas, I think that all house drains should, just before their connection with the sewer, be fitted with a syphon trap, as at Swansea, Leeds, &c., and that all water-closets of course should be fitted with syphon traps. That the sink pipes from sculleries, kitchens, baths, etc., should —as recommended at Manchester and Swansea—not be carried direct into the house drain, but be led outside the houses and there fall from a height not less than 1 foot into a covered receptacle, capable of being cleaned and fitted with a syphon trap, which should communicate with the house drain, and that the house drain itself should in all cases be fitted with a special ventilating pipe to be carried 6 feet above the top of the house.

As a still further and most important protection of houses, I would insist on every water-closet being fitted with an especial ventilating shaft, which should likewise be carried above the roof of the house.

The measures above-mentioned severally appear to me to be necessary to prevent the entrance of Sewer gas into houses, and I do not think that any one of them

could safely be dispensed with, especially in the case of house connections with Sewers conveying nightsoil.

The evidence of most Engineers I have asked seems to prove that the house drains as a general rule should not be of a less or greater size than 6 inches.

The trough water-closets in use at Liverpool, and the self-flushing tumbler water-closets at Leeds, where they answer remarkably well, appear to me to be the best kind for use in poorer districts, especially for closets which are frequented by more than one family.

As regards the disposal of sewage, I am certain that any attempt at rendering the effluent water pure by the separation of the mechanical impurities held in suspension must prove abortive, whether by the use of filters as at Coventry, or by precipitation with lime as at Leicester, or by simple settling tanks as at Birmingham, or by the A B C process as at Leamington, or by the use of chemical agents, as it is hopeless by either one or any of these operations to render the effluent water anything else than sewage.

All these plans appear to me to fail in meeting the requirements of the case, and the continued practice of allowing the effluent water to pollute running streams, as at Coventry, Birmingham, etc., seems to me to be exceedingly wrong.

Being quite convinced that, in the course of a few years, the question among practical farmers will be, not whether sewage can profitably and without danger to the public health be applied to land, but which farmer can succeed in getting even a share of the much-coveted sewage, I will first notice what appeared to me to be the best plan for effecting the separation of the solid matter from the sewage before its application to land, for this I consider, especially for India, to be a necessity. At Bedford, where the separation was only partially effected, there was in parts of the fields where the sewage had settled a dried

black scum, which under the hot sun of India would have given off an offensive odor.

In India, from the habit of the natives using water after defæcation, there will not be nearly as much solid matter as in the sewage in England.

The means that I have seen used for effecting its separation are, as I stated above, by simple mechanical deposition; by filtration through coarse gravel and stones; by precipitation with lime; by the use of other ingredients, such as in the A B C process (animal charcoal, blood, alum, and clay.) And the general plan adopted is to have at the outlet, extensive masonry beds, either covered as at Coventry, or uncovered as at Birmingham, etc., in which these operations are conducted, and from which an offensive smell is liable to be given off during the process of cleaning.

I believe all these plans will be entirely superseded by a simple but most ingenious contrivance invented by Mr. Baldwin Latham, and which I saw being experimented upon at Croydon.

In the middle of the stream of sewage at the outfall has been erected a turbine, which, acted upon by the cleansed sewage water, revolves between itself and the main stream of sewage an iron wheel about 14 feet diameter and about 2 deep, which is divided from the outer edge to the centre into compartments which intercept the solid matter, (consisting of all kinds of filth, among which I saw a dead dog, a tin biscuit box, road drift, etc.,) which is carried up until the compartment is over the central line, when the solid matter falls over the central axis which is furnished with an Archimedean Screw which worms it to a point outside the end of the axis, where another screw conveys it to wagons standing ready to receive it and by which it is periodically removed: while the side of the wheel furthest from the incoming sewage is covered with galvanized iron network, through which the strained water passes.

The next point to be considered is the quantity of land which would be necessary for a given population.

I do not think that this question can be answered off hand. At Barking and Croydon from 5,000 to 6,000 tons of sewage, or a quantity equal to 100 persons per acre, have been applied to every acre. At Banbury I was told this was too strong a proportion, and that 80 persons per acre would be a better dilution; but so much depends on varying conditions of population, soil, etc., that I believe this question will in each place have to be settled by the consideration of local peculiarities.

Regarding the, to me, most important question of how near to the inhabited place may a sewage farm be established without danger to the public health. I cannot say that from any evidence I have been able to collect I have arrived at any very definite conclusions based upon facts.

I enquired into the alleged outbreak of disease at Carlisle in consequence of the sewage farm, and the result will be found in the statement compiled from information kindly given by Mr. Morley.

As regards the Craigentenny meadows, near Edinburgh, Dr. Littlejohn says—"Under the influence of the improved agriculture of the present century, extensive swampy tracts which existed to the west of Edinburgh have been reclaimed, and it is to be regretted that the sewage of the inhabitants should now be employed to create an evil from which we have so recently been delivered. * * At present there is no control over this irrigation. No one can inspect it in operation without seeing that it is carried in the cheapest and most slovenly way, and the smells complained of arise chiefly from the foul state of the larger channels. * * * Edinburgh, from its situation, is peculiary exposed to suffer from the effects of the emanations from these meadows. The easterly are our most prevailing winds, which pass across these meadows before they sweep over the new and the more elevated portions of the Old Town; and it has been plausibly conjectured that the insalubrity of these winds depend largely on this contamination. But, at any rate, a city surrounded by swamps cannot be regarded in a sound sanitary condition, and it is highly probable that a great

part of the mortality of the Abbey and some of the poorer districts of the Old Town is in a great measure owing to the unhealthy character of these breezes which blow so continually during many months. It is difficult otherwise to account for the high death-rate of the district of the Abbey, in which there is little overcrowding and where only a small population can be said to belong to the poorer class."

Complaints have also been made regarding other farms, especially when they are first formed; but much of these complaints may be due to prejudice. Certainly during my visits I did not discover in any farm anything offensive to the sense of smell; but it is at present impossible to say what the effect may be on persons habitually exposed to currents of air passing over a farm whose success depends on irrigation with matters in solution which are readily putrescible.

Having then due regard to the dampness of soil, evaporation from surface, and increased vegetation consequent on irrigating land with sewage, I think that the question of distance from the inhabited place must depend to a great degree on the number of population, on the quantity of water carried to the outfall, and the capacity for absorption of the soil to which the sewage is applied.

For a population of upwards of 200,000 persons, with a quantity of sewage equal to 30 gallons per head, my impression is that a less distance than 3 miles would not be safe; but, as I said before, more evidence is required on the subject before a definite conclusion could be arrived at.

Engineers, Ratepayers, and Farmers would all be interested in reducing the distance as much as possible; but Health Officers would, in my opinion, view with anxiety any scheme proposing to put large volumes of sewage on land nearer inhabited places than I have mentioned.

Regarding the best method of applying sewage to the land, for England as well as India, I am convinced the simpler the means used the more surely will success attend the experiment, whether from a sanitary or pecuniary point of view.

The first thing is to have the land—as at Aldershot—scrupulously levelled on a slope. This may entail a heavy outlay at first, but such an expenditure will be amply repaid by the power of

utilizing equally every part of every field. Common sense should have prevented the adoption of the ridge and furrow system, as it stands to reason that the sewage matter must lie in the furrows for unequal distances, and that the ridges could get but little sewage; and yet I saw land at some farms in the ridge and furrow.

Of course the sewage would be delivered, whether by gravitation or by pumping, at the highest level of the farm, from whence main carriers which it is advisable should be covered, (as at Norwood) can be laid so as to command the areas below them, and these areas can be divided into panes by simple earth trenches, of course according to the contour of the land, but generally at about a distance of 70 feet from one another.

The expensive arrangements connected with these communicating carriers that obtains at Worthing are very unnecessary; a simple piece of board puddled in with earth being all that is requisite; but, as Mr. Clifford says in his most excellent report on the Warwick Farm, and to which I beg to call especial attention, the natives of India are all "skilled irrigators," and I have no fear but that they will, under supervision, lay out the ground to the best advantage.

All crops are improved by sewage, but, as Mr. Clifford says, Italian rye grass is a "gross feeder" and will take "any quantity" of sewage. After the 3rd year, however, it is advisable to plough up and re-sow either with rye grass or a root crop such as mangold wurzel.

Italian rye grass seems peculiarly well adapted for the supply of food for the cattle of a large city like Bombay; and though I have seen celery, broccoli, etc., etc., growing under the application of sewage, yet for India, knowing, as I well know, the childish fears and superstitions that the natives hold with regard to European interference with anything connected with their food, I should advise that at first sewage be applied only to food grown for cattle or to cotton fields, leaving the natives themselves, as doubtless they would when they find it would pay, to apply it for the growth of esculent vegetables.

About 5 or 6 crops of Italian rye grass, weighing from 16 to 20 tons per acre, seems to be the average annual yield of land irrigated by sewage.

I also directed my attention to the requirements of isolated places in rural districts beyond the reach of main sewers. The method I

think suitable for them may be perhaps best illustrated by relating the conditions I found on a small property I was consulted about and the measures I took to cure them.

The house, with garden attached, was situated within its own fence enclosing about 2 acres of land, and having only one cottage in the immediate vicinity.

In the garden was the servants' privy, which consisted merely of a seat over a bricked cesspool, which was within 40 feet of the stable well, the water of which was used for drinking. I had the cesspit thoroughly cleaned out, lime-whited, and the seat nailed up, and a Moule's Earth Closet placed inside. The pail being emptied every day into a trench in the garden.

Inside the house was a water-closet, which discharged into a cesspool 8 feet from the house, into which the water from the scullery also flowed, and the drain from both passed alongside a well used for drinking purposes, the cesspool being only 15 feet distant from, and on a higher level than, the well. The gravel between the cesspool and well was black and stinking. I had the cesspool cleaned out and lime-whited.

An earth closet was inadmissable within the house, so I placed within the cesspool one of Chessyre's Intercepting Tanks. This is almost hermetically sealed, as it is double syphon trapped. The solid matter, paper, etc., is arrested by a screen which permits the passage of water, which flows away through a syphon-trapped glazed pipe, and eventually discharges itself at a distance from the house beyond the property into a surface drain. The smell both inside and outside the house, before much complained of has entirely disappeared. The iron tank will require cleaning periodically, the patentee states once in 6 months, but this is a matter for experience to decide.

In order to secure the Drainage of subsoil, I would in all cases insist on the condition laid down by Mr. Chadwick, in his Paper on the Sanitary Principles of Cottage Improvement, and published in the Journal of the Society of Arts, viz., that the Water Table shall be lowered not less than 3 feet. I hold this to be of the greatest importance, especially in the malarious soil of India, where too often residences consist of one floor only, elevated above the ground by a plinth of a few feet high.

I would certainly prefer that the subsoil water was carried away by the rainwater drains ; but if that cannot be done I recommend

that all subsoil drains shall, before their junction with the sewers, be not only syphon-trapped but ventilated between the syphon and the sewer, otherwise sewer gas may find its way into the house.

As regards the Water Supply of Towns, I hold that the Medical Officer of Health should direct his attention primarily to the purity, and secondly to the sufficiency of the quantity of the water supplied to his people ; and that then, leaving the purely engineering questions of collection and stowage to those best fitted to deal with these matters, should see that by its distribution no injury was entailed on the Public Health. From the evidence I could collect, it appears to me that when a sufficient quantity of pure water is stored it should be at all hours of the day and night at the disposal of the people ; that in its passage from the Reservoir to the houses in the Town it should be guarded against any possibility of being tainted by any foreign matter whatsoever, and that the water used for domestic purposes should not be stored in any cisterns, which are always liable to be fouled, but that it should be drawn off direct from the mains.

If cisterns for water-closets are necessary to prevent waste, that only those on the principle of Messrs. Guest & Chrimes waste water preventers be adopted, as these provide a sufficient quantity of waste to flush the soil pipe on each occasion of the closet being used, but have no overflow into the sewer.

All house taps should be of the best possible construction, and obtained from the best makers such as Messrs Guest & Chrimes, or Messrs. Kennedy, as cheap fittings have been well described as the curse of water-works.

The waste of water should be prevented as it entails an unwholesome wetness of the subsoil, and consequently exposes the people to evils arising from damp.

To give some idea of the extent to which such waste may prevail, Mr. Latham in a recent report to the Croydon Board of Health, estimates that nearly 1½ million gallons are daily lost by leakage or illegitimate use.

The best kind of water-waste preventer for stand pipes in streets that I have ever seen is that made by Messrs Kennedy, and in extensive use in Birmingham. This will only supply water as long as an iron cone, which allows the water to escape, is turned by the

hand. It cannot get out of order or be kept open by improper means, and would be especially useful in Bombay.

I cannot but think that the water supply of Towns should be at once removed from the hands of Companies, and placed under the control of the sewer authorities.

But, few places in India would however be for years to come supplied by water brought in from a distance. The present supply is too often obtained from the village tank, which is almost invariably filled with the debris of vegetation.

Much I think might be done to improve the condition of this water by the use of the usual sand and gravel filters, but the filtered water should not, as at Rugby, etc., be exposed to the liability of being tainted by the floating impurities of the air, but be received into covered reservoirs from whence it might be drawn off as required.

As an Executive Health Officer I was much interested in seeing the way in which the scavengering of Cities is performed, and especially in the arrangements adopted in Edinburgh and Liverpool, for I am convinced that however well a Town may be sewered, yet, that the removal of the surface filth is a matter of equal importance. In India almost all the filth that can be collected is from the surface.

The faithful persistent cleansing of the surface can only be effected at a great cost, and in India we cannot at present reduce this, as in the United Kingdom, by the sale of the refuse as manure.

No one can peruse the earnest and invaluable reports of such men as

Dr. Gairdner, the Medical Officer of Health for Glasgow,
Dr. Littlejohn, „ „ „ Edinburgh,
Dr. Trench, „ „ „ Liverpool,
Dr. Little, „ „ „ Manchester,
Dr. Robinson, „ „ „ Leeds,
Dr. Davies, „ „ „ Swansea,

without feeling that the very greatest amount of sanitary knowledge is placed at the disposal of the various communities to which they belong. In the reports of these Officers are many hints which would be of the utmost value to the members of the Medical Services in India. "The Cholera Instructions" issued by Dr. Gairdner in 1866 are of infinite importance, and should be more generally known; but from these reports the lesson may be learnt, that a good sewerage system, a pure water supply, a scientific application of the sewage to the land, combined with a proper cleansing of the surface will be

inefficient as long as the tenements of the inhabited place are overcrowded, illventilated, and shut out from fresh air and light;—as long as the refuse and waste products of negligent traders are allowed to vitiate the atmosphere, as by the deadly arsenical and sulphurous fumes given out from the copper smelting furnaces of Swansea, or by the horrible bronchitic giving smoke belched forth from the chimnies of Lancashire, where earth, air, water, and animals are alike fouled by the shameless waste of coal. And here I would speak of what has indeed been told me by Municipal Officers in many Towns —that local self-government uncontrolled by the supervision of a central authority is, and must be a fatal bar to the sanitary improve- of that kind of property which stand most in need of it, and that the liberal minded men of such boards are out voted by the petty shopkeeper class whose only desire is to keep down the local rates, careless so long as they save their own pockets, whether the sanitary requirements of the poor are uncared for. It would, in my opinion, be a sad day for the welfare of India if the control of sanitary improvement were to be vested in the hands of local authorities, without the State exercising a due supervision in order to compel the sanitary requirements of the masses receiving that care and attention which they have a right to expect from a wise and provident Government.

I have the honour to be, Sir,

Your most obedient humble Servant,

T. G. HEWLETT,

Surgeon Bombay Army,
Health Officer & Coroner
City of Bombay.

October 15*th*, 1869.

Brook Cottage, Sunning Hill, Berkshire.

Information from the Towns of WIGAN, LANCASTER, TYNEMOUTH, and DOVER, was not received in time for publication.

BANBURY.

The following Statement is copied almost verbatim from a valuable Report, kindly placed at my disposal by the Author, THOMAS PAIN, ESQ., Clerk to the Local Board at Banbury. Certain Extracts from the Municipal Corporation Directory have also been embodied in it.

The district of Banbury comprises the corporate borough of Banbury, and the non-corporate township of Neithrop, in the county of Oxford, and Grimsbury, in the county of Northampton.

In 1852, the provisions of the Local Government Act were applied to Banbury, and a Local Board of Health formed. It is composed of 13 members, 6 selected from the Town Council, and 6 elected by the non-corporate parts, whilst the Mayor for the time being is ex-officio a member of the Board.

The principal trade consists in the manufacture of girths and webbings for exportation to the Continent; there is also an agricultural implement manufactory, and the Town is a centre for the sale of agricultural produce.

The population of the district in 1861 was stated to be 10,238; it is now (1869) estimated at about 11,000. The area is 4,000 acres, and the rateable value £39,227 17s. 6d.

In 1868, the rate in Banbury was			1s. 11d.	in the	pound.
„	„	Neithrop	1s. 9d.	„	„
„	„	Grimsbury	2s. 4d.	„	„

Shortly after the formation of the Local Board of Health, a system of drainage was commenced, the greater part of which was executed in 1855 and 1856. It carries away both the storm water and the sewage, and originally had its outfall in the Cherwell, a small river or stream which flows past the Town.

Complaints soon after arose from parties living further down the stream that the river was poisoned. Deposit and filtration tanks were erected at a cost of about £500, with a view of remedying the annoyance complained of; but as these works did not prove effective, the Board subsequently spent about £800 in making additional tanks, and first applied carbolic acid and lime, and afterwards perchloride of iron and lime, with a view to deodorize and disinfect the sewage, before it passed into the stream, but with the like unsuccessful result.

The owner of Twyford mill, 3 miles off, moved for an injunction in the Court of Chancery, which was granted, forbidding the further discharge of the sewage into the river, so as to cause annoyance and injury to the plaintiff. A writ of sequestration followed but was not put in force, as the Local Board determined to try the effect of the application of the sewage to the land, and accordingly a Farm was obtained at about a mile's distance from the Town.

The fresh sewage of the Town is conducted by a main sewer into the above-mentioned tanks, which may be described as deposit, filtration, and stowage tanks.

Filtration is effected through an upward filter composed of small stones and gravel.

After passing through the deposit and filtration tanks, where the solid matter, paper, etc. is arrested, the liquid sewage passes into a tank from a well connected with which, it is pumped by a condensing engine of 18-horse power up to the highest level on the north west corner of the farm.

The deposit and filtration tanks contain together an area of 510 superficial yards, and are capable of holding in the aggregate about 130,000 gallons, whilst the stowage tanks are of sufficient space to hold about 100,000 gallons—the amount of a night's flow; and this large tank space has been found advantageous, not only for the purpose of deposit and filtration, but in rendering any night pumping unnecessary.

The deposit and filtration tanks are in duplicate, and each set is emptied about once a month, and the deposit mixed with the sweepings of the streets and ashes, and other refuse collected from houses, is then conveyed in boats along the Oxford Canal which adjoins the sewage works, and sold to the occupiers of land on the banks of the Canal.

The farm contains about 60 acres of arable and 76 acres of pasture including one acre of roads. The soil is generally of a very stiff loam though in parts gravelly. During the winter of 1866, and the spring and part of the summer of 1867, the arable land was levelled, and with the exception of 2 pasture fields, containing 24 acres, which are in ridge and furrow, the whole of the farm has been also levelled. The part in ridge and furrow is irrigated, but is found not to be so suitable for sewage irrigation as the levelled part, inasmuch as the sewage is not so regularly distributed over all parts of the land; the sewage flowing from the two ridges gives too much to the furrows.

The sewage from its outlet on the highest level flows by gravitation through carriers or trenches cut in the earth on raised embankments, and from the main carriers is conducted by smaller ones to any part requiring irrigation, and after having passed over the land is discharged free from smell into the river Cherwell.

The principal crop is Italian rye grass; there is also an acre of cabbage, and a small quantity of carrots and parsnips, and about 14 or 15 acres of mangold wurzel. For all these root crops the sewage is applied to the land before sowing, and not whilst they are growing.

The following is an account of the Receipts and Expenditure in respect of the Farm for the year 1868 :—

RECEIPTS.

	£	s.	d.
Amount realized for sale of Rye Grass	561	16	6
Do. for Mowing Grass	347	18	2
Do. for Oats...	198	0	0
Do. for Aftermath	166	11	8
Right of Shooting over Farm and Sundries	6	1	6
	£1280	7	10
Deduct Payments	£1190	13	1
Profit on Farm ...	£89	14	9

PAYMENTS.

	£	s.	d.
A year's rent less property Tax ...	605	3	1
Rates and Taxes for the year ...	57	4	7
Coals for Engine	111	16	0
Labor on Farm, including Engine-driver's wages	216	2	0
Seeds, Implements, etc.	82	0	6
Manager's salary	45	0	0
Auctioneer's expenses of Sale, including Commission	73	6	11
	£1190	13	1

The adoption of the irrigation works cost £4,000, and £1,500 had been previously borrowed for the erection of tanks, etc., or £5,500 in all. This amount is to be paid off in 30 annual instalments of principal and interest at 5 per cent. The instalment therefore of principal and interest in respect of the loan of £4,000, borrowed to carry out the Irrigation Works would be £250 (£200 interest of £50 principal). If therefore the profit on Farm has to be deducted from this, there would be a loss of £160 5s. 3d., which would be about 3½d. per head of the whole population (estimated at 11,000) for the removal of all of the excreta of the inhabitants.

The death rate has decreased since the introduction of the Public Health Act, when it was 26 per 1,000 of the population.

In	1859	it was 20	per 1,000.
	1860	,, 18½	,,
	1861	,, 14	,,
	1862	,, 14½	,,
	1863	,, 17	,,
	1864	,, 17½	,,
	1865	,, 20	,,
	1866	,, 17	,,
	1867	,, 19	,,
	1868	,, 20	,,

so that the average of the last 9 years is 18 per 1,000.

The drinking water supply of Banbury is in the hands of a company. Its source of supply is from the river Cherwell, and the works are situated on the river, about a mile above the Town. The river water flows into two filtering beds, which are of the usual construction: the water filters through a layer of about 15 inches of fine sand, thence through about 12 inches of fine and 9 inches of coarse gravel, and lastly through about 6 inches of large rubble stones, which are laid in covered bricks with apertures at intervals. The filtered water passes through these brick drains to a centre drain, which opens into the bottom of the pure water well, from whence it flows into a suction well, and is pumped by a 16-horse power engine to a reservoir on the top of Hasington Farm, from whence the Town is supplied. This reservoir holds 248,000 gallons; but only about 190,000 gallons are pumped daily.

WARWICK.

The following Statement embodies information kindly given me by J. Fenna, Esq., Borough Surveyor; and also a most valuable report by W. Clifford, Esq., under whose able management the sewage Farm has obtained so much success. Extracts have also been made from the Municipal Corporations' Directory.

The Town of Warwick has water communication with many Towns by means of the river Avon on which it is situated; and also by means of the Warwick and Birmingham, and the Warwick and Napton Canals. The Oxford and Birmingham branch of the Great Western Railway also runs through the Town.

Population, according to the census of 1861, 10,570.
Estimated in 1869 to be about 11,000.
Inhabited houses in 1861, 2272.
,, ,, 1869, 2390.

A main drainage system was carried out in 1851. District sewered covers 1270 acres. The street gulleys and the roofs of the front of Houses are connected with surface drains, which convey the water from them to the river

Avon. The water from the back yards and from the roofs at the back of houses finds its way into the sewers. The main sewers are glazed earthenware pipes, varying in size from 18 in. at the outlet by 15 in., 12 in. to 9 in. at the top levels. There is a flushing pipe with a 2 in. cock at the head of every main pipe. Ventilation is effected through the rain water pipes.

About 200 houses in the Town are not connected with the sewers; at these there are cesspools, but they are being gradually abolished; so that in a short time all the houses will have water-closets. Every water-closet is fitted with a syphon trap.

The scavengering of the Town is performed by men employed by the Corporation.

Mr. Clifford's Report.—

The sewage flows by gravitation from the Town to the pumping station, which is situated on the Stratford road about ¾-mile from the Town. It empties into two reservoirs, each 76 ft. 6 in. long, and 17 ft. 6 in. wide at bottom.

112 ft. 6 in. „ 33 ft. 6 in. „ at top.

The depth of these reservoirs is 9 ft. 6 in., but they fill only to 8 ft.

At about 12 ft. from the entrance of the sewer, a screen composed of wooden planking perforated with holes about 1 inch in diameter, and separated by about 6 inches from each other extends across each reservoir. This screen is let into brickwork, and at the bottom and in the centre of each screen is a sluice. The paper and solid matter are arrested by the screen and periodically (about once in 12 months), are taken out, mixed with ashes, and sold as manure.

The sewage is then pumped by two engines, made by Gimson & Co., Leicester, each of 25-horse power. Each engine works a double acting pump, 18 in. diameter, 30 in. stroke; maximum speed 25 revolutions, minimum 20. Each pump forcing 1,080 gallons per minute. They pump the sewage through a rising main of 16 in. to a point 73 feet above the bottom of the well, on the Farm ¾-mile distant.

The Warwick Farm consists of 102 acres generally of heavy clay land. It is about a mile from the Town. It is taken on lease of 21 years on a rental of £300. The tithes and taxes amount to about £100, making a total of £400. The lease dates from Lady-day, 1867. It was then about half arable, half pasture on the old ridge and furrow. With the exception of 1 field (12 acres) of old pasture, all the land was broken up, got into shape, and seeded down with Italian rye grass within the year. The sewage was first delivered in the last week of July, 1868; but there were frequent interruptions until December, since which time the delivery has been constant.

The upper portion of the Farm (25½ acres) is undulating, falling on two sides at different inclines, (which cover about 40 acres) to the flat land, containing about 36½ acres.

The irrigation is by catch-water pane and gutter, ridge and furrow, and bed, and the sewage is conveyed by open runs. The arterial drainage in 2 fields is perfect, on others very defective, some not at all.

The plant virtually lost its first year's growth, and suffered great injury from the heat and drought of 1868. No produce was obtained until the autumn of that year.

This year (1869) 4 and 5 crops have been cut to date (September). With

the exception of the 2nd spring crop all have been light. The yield of our best fields is as follows to acre—in tons :—

No. 1.	2.	3.	4.	5.	Time of cutting.
2.2	3.	2.12	1.18	3.16	Feb., March, and April.
12.8	10	3.8	6.16	5.8	May and June.
6.0	4.17	10.10	6.7	8.4	June and July.
3.4	3.16	4.10	4.7	3.10	July and August.
		3.0	2.16	2.13	August and September.

No. 1 is now (September) ready for cutting and No. 2 will be shortly.

The plant is becoming thin, dying out fast in many fields, and is largely replaced by natural grasses.

Owing to the nature of the soil, breaking it up is a serious and expensive matter, it can be only worked at certain seasons ; in fact when it can be caught,—to use a homely but apt expression.—the land is either "all bricks or all mortar." We have tried ploughing and skim ploughing and burning, but found both alike unsatisfactory and costly. The loss of time is frequently great, and the horses stalk and puddle the ground to an injurious extent. We are now trying the experiment of spade digging.

Grass Demand.—Last year the grass was almost unsaleable, as the greatest possible prejudice existed against the use of sewage grass. The prejudice has fled in the face of experience; the demand this year has been quite equal to the supply. Prices varied from 12/- to 16/- per ton. We cut the grass ourselves, and allow carts to go on the fields when possible, otherwise we convey it to the roads.

The field of old pasture, 12 acres, is ridge and furrow, with considerable fall on one side. It has been brought under irrigation.

The May crop was sold off in June, realizing £4 17s. 6d. per acre. Since then I have cut an aftermath for £30, and a second aftermath is forward.

Exclusive of loss in rental the cost of laying out the Farm has been about £10 per acre. Little or nothing has been done to the roads which are in a bad state: to put them into working order would cost at least £5 per acre.

There is a brook running round two sides of the Farm, into which the drainage of the surrounding land falls. We are not allowed to use the brook or any of the ditches that drain into it, therefore we have a catch drain surrounding the Farm which conveys our drainage to the outfall, when it passes under the brook by 2 16in. pipes acting as syphons; it then runs down common watercourses into the Avon $\frac{3}{4}$-mile distant. Being on clay our effluent discharge is large.

We have grown a few beans and potatoes which have done well. Virtually the Farm is in grass, and we shall continue it, as no other crop is of so little trouble and pays so well when the demand is good, as with us at present. We purpose laying out 3 acres with mangolds next season. The sewage of about 2,050 houses mixed with about 600,000 gallons of water comes into the Farm.

The delivery of sewage is very unequal, falling as low as 400,000 gallons daily in very dry weather, and rising over a million and a half of gallons daily in very wet weather. Everything is pumped up and the sewers flushed out once a week ; when this is done the sewage is pumped direct from the sewers, passing by iron pipes under the bed of the reservoir to the pumping well.

Most people anticipated nuisance from the working of the Farm; for a time some fancied there was, but truth has convinced every one now, that a

sewage Farm is no nuisance, that it creates in fact less nuisance than often arises on an ordinary Farm when manuring the land. Sewage fresh and fresh has at the worst but the aroma of cabbage water, and in that state is harmless. When allowed to stand for 24 hours, decomposition sets in and noxious gases are given off, especially sulphuretted hydrogen, the presence of which may be known by the smell of rotten eggs, so common in the lanes and gullies of Calcutta.

The marvellous effects of sewage on land in developing its productive powers is shewn in the fact of its giving 6 and 7 crops of grass in a climate like ours, where only one could be had without it. Sewage holds in solution and suspension the constituents necessary for the growth of the plant; water is the vehicle of supply. When a crop is cut the constituents are returned to the land and a fresh crop springs up. In the climate of India, which I know very well, after 27 years' sojourn there, I should anticipate marvellous results from the skilful application of the sewage to the land. In the natives themselves you have skilled irrigators; but I should imagine that their religious prejudices would prevent them from applying sewage to their own crops; but this would yield in time, when they saw the wonderful results. Whether rice will stand sewage treatment, will need experience to decide: to some extent it certainly would, if not to that of rye grass, which is a gross feeder and will take "any quantity" of sewage without injury. At all events the land could be treated with sewage for the next crop, and thus the area of its usefulness would be largely extended.

The application of sewage to all crops has been satisfactorily demonstrated that it can be usefully and profitably so employed in India I am as certain, as I am of my own identity. Time, experience, patience, and skill, are required, and these we can command to carry the measure to a successful issue. One has but to see the Warwick Farm to see how readily it is done, and how satisfactorily and successfully sewage irrigation works.

The Warwick Waterworks were carried out the same time as the Drainage Works. The water drawn from the river Avon flows through an earthenware pipe 18in. diameter into a settling tank

100 ft. long by 50 ft. 6 in. broad at top, sloping down to
60 ft. long by 36 ft. broad at bottom.

Here the floating impurities are arrested and the water flows into 2 filtering beds, one being 100 ft. long by 78 ft. broad at top, sloping down to
66 ft. long by 44 ft. broad at bottom.

2nd.—110 ft. long by 88 ft. broad at top, sloping down to
78 ft. long by 46 ft. broad at bottom.

Down the centre of each bed runs a pipe with 5 cross branches. The water entering at the top filters through sand, 12in.; fine gravel, 6in.; coarse gravel, 3ft.; large stones, 18in.

The filtered water passes to a well from whence it is pumped by an engine a distance of 1¼-mile, to a service reservoir in the Town, a height of 128 ft. from the bottom of pumping well.

The main is 12in. House connections for drinking purposes are laid direct from pumping main. The supply is intermittent, but the pumps are in action from 6 a.m. to 9 p.m. The Corporation insist on having one of Messrs. Guest & Chrimes' water-waste preventors fixed to every closet, because the water by them is economized, and a better flush is secured. Lambert's screw taps are used in the houses. About 56,000 gallons are kept in the reservoir on the top of the water tower, which is 70 feet in height, in case of fire. The average daily supply amounts to 310,000 gallons.

The cost of the execution of the drainage and water supply works amounted to £25,000. This sum was raised by a mortgage of the general district rates (3/- in the £1), and is repayable (principal and interest at 4¼ per cent) by 30 annual instalments. This loan was advanced by an Insurance Company.

This loan of £25,000 does not include the cost of the Sewage Farm, which amounted to £11,000 in addition, which was raised by mortgage of same rate at 4½ per cent interest, repayable in same number of years.

COVENTRY.

The following information is gathered from a Memorandum supplied to me by the Borough Surveyor, E. J. PURNELL, ESQ., and I have also made extracts from the Municipal Corporations' Directory.

The Town of Coventry is an important manufacturing City in Warwickshire, the manufactures include silk fabrics and ribbons, lace, carpets, watches, and machinery.

The Public Health Act was applied in the year 1849.

Statistics:—Population estimated at 42,000; inhabited houses, 10,400; rateable value, £99,664; acreage 1,660 acres, of which 600 are built upon; number of streets, 171; length of streets, 27 miles; average annual mortality for the 10 years 1851-1860, 25 per 1,000. The sewerage carries off both rainfall and sewage. The main sewer is about 2 miles long, and varies in size from 3 ft. 6 in. by 2 ft. 6 in. to 4ft. by 3ft. at outfall; it is built of brick, eggshaped, invert set in cement; 4 or 5 miles of the subsidiary sewers are glazed earthenware pipes from 6in. to 12in. in diameter; the number of water closets, 3,813, but many of these are double making the agregate nearly 5,000; there are numerous cesspools in the Town. The main sewers and subsidiary drains are flushed by perpendicular shafts charged with water from the nearest hydrant.

The sewers are ventilated principally by down spouts, there being 1,230 connected in the Town.

Total cost of sewers, £35,000, this includes £6,000 for constructing works, purchase of water power, etc. The main sewer cost per yard about 23/-.

The outlet of the sewers is distant about a mile from the Town, and by it the sewage is conducted to the tanks which are in duplicate.

The tanks are brick-work enclosures divided on either side into two partitions, each communicating with a central drain. They are 124 ft. long and the 1st tank is 18 ft. broad, the 2nd 9 ft., and the central drain 6 ft., they are 14ft. deep. Between No. 1 and No. 2 tank, and between No. 2 and the central drain are filter beds which are enclosed by perforated planks of wood 7ft. 6in. high. The filter beds consist of large stones at the top, gradually diminishing in size until there is a layer of coarse gravel at the bottom.

The sewage water entering No. 1 tank, filters through the 1st filter bed into No. 2 tank, and any solid matter which may pass through No. 1 filter bed is arrested by No. 2, after passing through it escapes into the central drain, by which it is conducted through a culvert into the river Sherborne. About 1,800,000 gallons per day passes through the tanks.

The tanks are covered by brick arches, and over each tank are 5 iron gratings, over which a travelling crane runs upon rails, to this is attached a bucket holding about 28 gallons. The tanks are cleaned out once a month, and the solid

matter at the bottom is run into beds formed by street sweepings, with which it is covered and mixed, and sold for about 2/- a ton. About 1,440 tons of solid matter are thus intercepted during the year. The site on which these works stand covers 4,450 square yards.

The sewage tanks, including 4½ acres of land and 1,100 feet of inlet sewer, cost £4,320.

The annual expenses of the sewage works amounts to £140.
Amount received for manure in 1868, £120.

In Coventry there are about 6 large dye works, and although most of the solid matter is intercepted as explained above, the sewage runs away as a black inky fluid, and perfectly discolors the stream.

Just before the sewage is discharged into the river, it is occasionally intercepted and allowed to flow over about 14 acres of land, about 4 acres of which are sown with rye grass, and 10 with common English grasses.

In 1868, from the 4 acre field, the crop fetched	£35	0	
The aftermath, or joist	£15	0	
		£50	0
From the 10 acres, there were 3 crops of hay	£180	10	
The feeding off	£15	0	
		£195	10
Total		£245	10

268 acres have been purchased on high ground sloping down to the river, for £27,000 and are about to be laid out for sewage irrigation. For these the sewage will have to be pumped up to the highest level.

The Waterworks at Coventry were erected by the Corporation under a Special Act in 1846. They cost £33,000, the money was borrowed by mortgage at 4 per cent; annual working expenses, £2,700 to £2,900; profit, from £700 to £900

The supply is obtained from the following sources:—

1st.—From a spring at Radford, the water of which is conveyed for about a mile to the filter beds.

2nd.—From a land-spring from the gardens at the north-west of the Town, about ¼-mile distant. Both the above are surface-springs and are dry during summer.

3rd.—From a small brook called the Barley brook, which flows from Radford; the water from this is let in by a sluice into a filter bed composed of sand 22in., fine and coarse gravel and stones, 24in., below are cross drains which carry the water to a centre drain, through which the filtered water passes into a collecting tank.

4th.—From Artesian wells sunk into the new red sandstone; these are 4 in number, 1st is 300 ft. deep; 2nd is 250 ft. deep; 3rd is 75 ft. deep; 4th is 75 ft. deep; these discharge direct into the collecting tank, which is circular in shape, 100 ft. diameter by 15 ft. deep, at 14 ft. 4 in., the water over-flows into the river Sherbourne.

The suction pipe, cast iron, 2ft. diameter, dips into the collecting tank to within 11 inches of the bottom; there is a wall about 3ft. high, built about 18in., from the suction pipe, to protect it from weeds, and especially from the silk weed which is very troublesome, and grows with great rapidity in the tank which is open; the American weed also grows in the tank but is not objected to.

The water is pumped up by two beam, double action, double cylinder engines, one is of 60 horse power, the other of 40 horse power; the 60 horse power one drives about 63 gallons a stroke, and about 1,000 strokes per hour, the water passes first through an air vessel and then through a 14in. iron main into the Town. There is also an air vessel over the suction pipe. The pumps are kept in action for about 12 hours.

The water passes by the mains through the Towns and supplies it in its passage, the surplus is pumped up to a service reservoir built on Barr's Hill, Radford, distant about a mile from the works, and situated 100 feet higher, and over a stand pipe 40 feet high, making a pumping lift of 140 feet. The average daily supply is about 700,000 gallons. The number of fire plugs is 109; hydrants, 294; standposts, 39; houses supplied, 7,364; water closets, 3813; meters, chiefly Kennedy's, 66; public wells and pumps, 21.

The water works stand on 4 acres of land, and there are 6 boilers altogether, though only two are used for each pump, these are fitted with Hulton's smoke burners. There are also public baths belonging to the Corporation, built at a cost of £5,325. They are kept open at an annual loss.

RUGBY.

The following statement is compiled from information kindly afforded me by I. M. Wratislaw, Esq., Town Clerk, and J. E. Palmer, Esq., Town Surveyor.

The population of Rugby, according to the census of 1861, amounted to 7,818, but is now (1869) estimated to have reached about 9,000. The area of the parish is 1,600 acres, and there are estimated to be about 1,500 houses. The main sewers carry off both the rainfall and sewage; they consist of glazed earthenware pipes varying in size from 2ft. at the outfall to 9in, and extend over about 5 or 6 miles.

Water from the hydrants is used for flushing these, and they are ventilated through charcoal trays into the street at the manholes. Nearly all the houses are fitted with water-closets, which are connected with the sewers by pipes, varying in size from 4in. to 6in. The water-closets are syphon trapped. The sink connections 3in. in diameter are well trapped.

Ashes and dry refuse are collected in the back yards of houses in covered ash-pits, about 4 ft. by 3 ft., and 3 ft. or 4 ft. deep. The owners make arrangements to have these pits cleansed; but there is no systematic inspection by the local Authorities whether they are done so or not.

The sewage flows by gravitation through a high and a low level sewer to the Farm, which is situated about a mile from the Town. There are 58 acres on the Farm, 40 acres of which are irrigated by the high level sewer, and the remainder by the low level.

At the high level inlet the sewage is received into a diverting well, from which it flows into one of 2 depositing tanks which are open, and in which are fixed double strainers made of perforated wooden planks. The solid matter is arrested and is deposited, while the liquid sewage flows out through a 15in. earthenware pipe into the main carrier.

Each deposit tank is used in turn, and is periodically (about once a month) cleaned out, and the solid matter removed and covered over with refuse from the carriers, and used as manure.

The main carrier is simply an earth trench, with a fall of 1 ft. in 200 ft.; smaller ones with falls varying from 1 ft. in 600 ft. to 1 ft. in 1,000 ft. communicate with it.

The main carrier is 2 ft. 6 in. broad at the top, tapering down to 1 ft. at the bottom; it is 18in. deep. This is considered to be unnecessarily large: and one of 2 ft. broad at top, 9in. at bottom, and 1 ft. deep, would be preferred.

At intervals, depending on the nature of the ground, are wooden sluices let into brick wall sides.

The principal crop is Italian rye grass, though some mangold is planted. A crop of rye grass takes on an average a month or 6 weeks to grow. After cutting, the ground is saturated with sewage for 3 or 4 days; this of course varies with the amount of rainfall.

The sewage from the low level is obliged from the nature of the ground to be allowed to flow over growing crops, but they are none the better for it.

The effluent water passes off the land into the Avon, two miles below the source of drinking water supply to the Town; but during the summer the land absorbs all the water.

The land in which rye grass has been sown must be ploughed up and sown in with fresh seed every 3rd year; but it is advised that a crop of roots should be sown instead of rye grass every 4th year.

The sewage irrigation works cost £4,700. The first year's receipts were £350; though only a portion of the land was brought under cultivation. The money was raised on mortgage of rates at 4½ per cent interest, principal and interest to be repaid by yearly instalments in 30 years.

Rugby Waterworks.—There are two sources of supply; the principal one being from rainwater which is collected in a rural district, over an area of about 700 to 800 acres. The water so collected flows from numerous points, through earthenware pipes, gravitating by a central main to a covered reservoir, situated at about a mile's distance from the Town: this reservoir holds about 150,000 gallons. The water is pumped from this reservoir by a 15-horse power horizontal engine, to a tank holding about 50,000 gallons, on the top of a water tower 75 feet high. It thence flows through an iron 9in. main to the Town by gravity: it is laid on to nearly all the houses.

The pipes for drinking water purposes are connected direct with the main; but as the supply is intermittent, there are cisterns made of either iron or lead: water-waste preventers are not used. The above supply runs short during the hot weather, and is reduced to less than 35,000 gallons per day.

The subsidiary supply is obtained from the river Avon, about a mile from the Town. This flows into a well, from which it is pumped into a settling reservoir, holding about 2,500,000 gallons.

The mechanical impurities are deposited, and the supernatant water flows into filter beds, of which there are 2, each being about 40 feet long by 35 feet wide.

The filtering medium is composed of—fine sand, 6in.; magnetic carbide of iron and sand, 6in.; medium sand, 9in.; coarsest sand, 4in.; Gravel—size of peas, 4in.;—size of beans, 4in.;—size of walnuts, 6in.;—size of eggs, 4in.

The water after passing through the above, escapes by brick drains to a central drain, from which it is conducted through an iron sliding tube, into an open filtered water reservoir, holding about 70,000 gallons; and from thence it is pumped by the same engine to the water tower twice a day; from the water tower it flows through the same mains at the upper works into the Town.

The height pumped is 108 feet: the pumps are in action about 12 hours per day, and about 180 to 190,000 gallons are pumped during that time.

BEDFORD.

The following statement has been compiled from information kindly given me by the local Authorities. Extracts have also been made from the Municipal Corporations' Directory.

The Town lies on both sides of the river Ouse. The Bedford level was reclaimed by drainage from being a salt marsh, and a great trade is carried on in corn and other grain.

Malt, coal, iron, and timber are considerable items of commerce carried on by means of the river which is navigable to the German Ocean. Lace making affords employment to great numbers of women and children, and there is in the Town one of the largest agricultural implement manufactories in the Kingdom.

Population, 1869, (estimated) 16,000; area of Borough, 1,962 acres; area sewered, 1,000 acres; number of houses, 3,400.

There are very few cesspools in Bedford, the number that do exist is supposed not to exceed 150.

Works of main drainage have been executed at a cost of £18,000. They are on the separate system, the storm water flowing to the river. There are 2 lines of main sewers, a high and low level; both discharge by gravitation to pumping station, a mile from the Town.

The main sewers are constructed of brick, and are egg-shaped. At the outfall the size is 4 ft. by 2 ft. 8 in. The smallest size of brick sewer is 2 ft. by 1 ft. 8 in. The subsidiary earthenware pipes range from 1 ft. 6 in. to 1 ft. 3 in. There are 2,464 water-closets connected with the sewer by 9 in. or 6 in. pipes, fitted with syphon traps.

The drains from the sinks, which are syphon-trapped, are on the outside of the walls of houses.

The sewers are flushed at their extreme ends from hydrants, through 3 in. pipes.

There are 90 special ventilating shafts, of 3 in. or 4 in. diameter, running up from the crown of the sewers to the top of chimney stacks.

There are manholes at the junction of each street, which are fitted with charcoal ventilators; and the rain-water pipes are also connected with the sewers, when they do not open near the windows of houses.

The soil is gravel and sand on the south side of the river; limestone and clay on the north.

The main sewer from the high level is laid under an embankment reclaimed from the river, and about a mile long. The sewage from the low level on the south side of the river, receiving the sewage of about 1,000 houses, passes by an iron pipe 15 in. in diameter under the river, and joins the main outlet. The main sewer flows into a brick tank, 12 ft. by 6 ft., by 6 ft. deep. At about 2 ft. from the outlet, and extending across the tank, is an iron grating 6 ft. high, the bars of which are about ¼-inch apart. By this grating, the paper and solid matter are retained. The sewage then flows into a tank about 30 ft. by 12 ft., and 12 ft. deep, half way down which is a culvert which leads to a centrifugal pump, by which the sewage is lifted into a cast iron cylinder 1½-in. thick, 6 ft. diameter, and 15 ft. high, from which it flows by gravitation over the land, being conducted to it, for a distance of about ½ a mile, through an iron pipe 1 ft. 6 in. in diameter.

Around the pumping station is a garden, in which there were at the time of my visit, growing beet-root, broccoli, asparagus, onions, lucerne, white turnips, etc. The sewage flows in this garden through earthen trenches, and is applied at intervals, perhaps of a week, to these crops for a day or two.

The sewage flows on to the Farm from the cylinder, through a pipe into a supply well, and thence through earthenware pipes carried along the highest ridge, from which earthenware carriers are laid at intervals of 60 or 70 yards. The sewage flows irregularly over the ground, as the land was not in the first instance properly levelled.

The Farm contains 50 acres; 37 of which are laid out in rye grass, 10 in mangold wurzel and cole rabbi, and 3 in wheat.

A crop of rye grass takes about 6 weeks to grow. After cutting, the sewage is allowed to flow over the field for 3 or 4 days, according to the state of the weather. No sewage is then allowed on for another week, when it is again applied. It should be applied 3 or 4 times during the growth of the crop. Rye grass sells for from £4

to £8 per acre. The field of mangold I saw growing in September, was planted in April. It was irrigated about a month after sowing, and once every fortnight since. It is intended to be pulled in October, and then the ground will be soaked with sewage during the winter, and early in the spring seeded down with rye grass. About 350,000 gallons were being pumped over the land in September, when the pumps were in action about 5 hours during each day: 600,000 gallons can be pumped in the 24 hours. When the pumps are not in action, a sluice is shut at the outlet, and the sewage is ponded back in the main sewer for about a mile.

The effluent water finds its way through various ditches into the river, about 1½-miles below the Town.

Bedford Waterworks.—Established 1868.—Supply from an artesian well sunk in the limestone rock. The well is 14 ft. deep, and the boring 18 ft. into the rock. This yields 205,440 gallons a day, which are pumped by a beam engine into a reservoir, capable of holding 800,000 gallons. The reservoir is situated about a quarter of a mile from the well, which is in a hollow, and about 1½-miles from the town. The water is lifted about 160 ft. into a reservoir, and then is conducted by iron mains, 1 ft. diameter into the town. The supply is on the constant system. All water-closets are fitted with water-waste preventers, holding 3½ gallons, after the pattern made by Messrs. Guest & Chrimes. The water-closets are fitted with Messrs. Doulton's, of Lambeth, pans.

The water works, including the main sewerage embankment, cost £23,000.

LEICESTER.

The following statement has been compiled from information kindly given me by E. L. Stephens, Esq., the Borough Engineer, and from extracts from the Municipal Corporations' Directory.

Leicester is the centre of the worsted hosiery manufacture, which is the staple trade of the Town, along with lace, sewing cotton, wool combing, worsted spinning, &c.

Population estimated at 90,000; area of Borough, 3,000 acres; area of district sewered 1,200 acres; No. of houses, 20,000

The sewers which carry off both storm water and sewage, formerly discharged into the river Soar, at the nearest points. An intercepting sewer has since been built, with which the sewer from the west side of the Soar, communicates in its passage to the sewage works, which are situated on land adjoining the Abbey, on the north side of the Soar. The main sewers are built of brick, are circular in form, and vary in size from 2ft. 6in., to 5ft.

Flushing is effected by pipes from the hydrants, and from moveable tanks large enough to hold about 1,080 gallons, which are suddenly discharged into the sewer. It is calculated that about a million gallons of water are used during the quarter in flushing the sewers.

The method of ventilation adopted is to connect the sewers with the engine shafts of different manufactories. There are now (1869) 25 such connections. The rain-water pipes also communicate direct with the sewer, and ventilation is effected through them.

There are only about 6,000 water closets in the Town; but on cottage property, there is on an average only one water closet for every 4 cottages. The size of the water closet connections, varies from 6in. to 9in., they are all syphon trapped. The sinks are situated outside the houses, and communicate by a short drain, which is furnished with a trap, with the main sewer.

Middens or ash privies are numerous throughout the Town; they are estimated to amount to between 3,000 and 4,000. These are also connected with the sewers, so that the watery matter finds its way into them. The solid matter consisting of nightsoil and ashes remains, and is removed on an average once in 6 months.

The Construction of the sewers is estimated to have cost £40,000.

The Sewage Works.—The sewage flows through a barrel culvert 4 ft. 6 in. in diameter, into 2 wells, each 7 ft. by 11 ft., and 12 ft. deep, from which it is pumped up 20 ft.

into reservoirs, which are 200 ft. long, 45 ft. broad, and 14 ft. deep. The reservoirs on section are triangular in shape, and so constructed that the gutter is in the centre.

The engines used for pumping are 2 Cornish engines, which consume about 20 tons of coal during a week, in lifting about 35 million gallons of sewage; they are each in action for about 12 hours per day.

In its passage from the supply well, the sewage receives, and is intimately mixed with, a solution of lime of the strength of 1 ton of lime to a million gallons of water. The sewage and lime then pass slowly over the reservoir, where the lime precipitates the solid matter.

The effluent water from the reservoir passes over a weir into the river Soar, which soon after joins the grand junction canal.

The reservoirs are in duplicate, and the sewage flows into one whilst the other is being emptied. This occurs about once a month, when the sludge at the bottom is lifted, and run down into earth embanked beds, where it is allowed to remain for 2 or 3 years to consolidate. It is then sold for one shilling a cartload as manure.

The sewage works cost £25,000.

The yearly expenses of working them amounts to £1,300.

From which must be deducted sale of manure ... £300.

Leaving £1,000 as the expense of working them.

The Water Supply of Leicester is under a private company. Two brooks, the Thornton and Carr are impounded, and the water is collected in a reservoir, which holds 365 million gallons. The water passes through 4 filter beds, and is brought down 10 miles by an iron 24in. main to the service reservoir, which is 100 feet lower than the main reservoir. The service reservoir is situated a mile from the Town, and is about 90 feet above it. The water is distributed through about 25 miles of pipes, and is on the constant supply system. There are about 14,000 connections. No cisterns are allowed in houses except for water-closets when they are compulsory: each service cistern holds about 2 gallons. Messrs. Stock Bros., and Taylor's taps are recommended to be used, but Messrs. Guest & Chrimes' taps are permitted. About 21 gallons per head per day are supplied. These water works cost about £90,000.

The death rate for the year 1868 is stated to have been 27.855 per 1,000.

BIRMINGHAM.

The following statement has been compiled from information kindly given me by W. Till, Esq., Borough Surveyor; J. W. Gray, Esq., the Engineer to the Birmingham Water Works Company; and also from some extracts from the Municipal Corporations' Directory.

Birmingham is the great centre of hardware manufacture for England and the World. Every description of hardware, from the most ponderous steam engines to the smallest piece of jewellery being made here.

Population by census of 1861, 296,076; 1869, estimated 360,000; inhabited houses by census 1861, 59,060—by estimate, 1869, 70,000; estimated number of electors, 43,000, burgesses 47,000; gross estimated rental, about £1,260,000; rateable value, £1,052,796 19s. 9d.; area of borough, 8,420 acres; area sewered, 7,320.

The Main Drainage Works.—The length of sewers at present constructed amounts to 97 miles, leaving 36 miles still to be made by the Council. The cost including compensation of land, amounts to £200,000.

They consist of egg-shaped brick sewers and circular pipes, varying in size from 5ft. 9in. by 3ft. 6in. down to 12in. pipes. The main sewers are ventilated by shafts from their sources to the surface of the roads and are flushed by gates fixed in them and from shafts at dead ends.

The house connections are 9in. and 6in. pipes, with 4in. soil pipes. The proportion of water closets is very small, and every house almost has its privy and ash-pit.

The scavengering was formerly let to a contractor, who failed to perform the work satisfactorily and it is now done by the Corporation.

Outlet Works.—The sewage flows down by 2 egg-shaped mains 5ft. 9in. by 4in. Their contents are received into a large culvert, which at either end has 7 arches, and which forms the side of 2 depositing tanks, which are 330ft. long, 90ft. broad, and 6½ft. deep. The tanks are in duplicate, to allow of one being used whilst the other is being cleaned.

Each depositing tank is divided into 3 sections: the sewage is allowed to flow into 1 tank for 14 days it is then diverted into the other whilst the full one is being cleaned; all the supernatant water is allowed to run off and the mud and sludge deposited at the bottom is lifted about 14 feet by a 13 H.P. engine, and run down into a depositing ground which covers about 7 acres, to a depth of about 4 feet. It remains on this ground for about a year, until it has become sufficiently consolidated for removal, but is covered over with gypsum to prevent smell at an annual cost of £100. About 42,000 cubic yards are removed from the tanks during the year.

13,615 tons of sewage manure were disposed of during the year 1867, and were sold for 9d. per ton. The charge for the manure at the works is 1/- per cart, 2/6 per waggon, and 29/- per boat load.

The Birmingham and Fazely Canal adjoins the works.

£25,000 were expended in construction of the works, purchase of land, etc., etc., and about £2,000 is the annual cost of maintainance.

The effluent water runs into the river Thame.

Experimental Farm at Outlet.—Mr. Till's Report 1868.—About 50 acres of land belonging to the Council were double dug, levelled, and the necessary road carriers constructed so as to allow of the same being seeded down with Italian rye grass prior to July last, whilst 6 acres, on which the liquid sewage cannot be conveyed without pumping, have been planted with mangold and other experimental crops, such as clover, celery, cow-cabbages, swedes, turnips, etc., but owing to the lateness of the time of planting, and the excessive heat, the crops were not large.

The remainder of the meadow land was irrigated with the sewage several times during the season, and let out to cow keepers.

The amount received for sale of rye grass, was £314 9s. 3d.; for hay for cattle, £517 1s. 11d.; and for barley, oats, mangold, etc., £142 10s. 11d.; making a total of £973 14s. 1d.

The Water Supply of Birmingham is in the hands of a private Company. Source of supply,—river Tame and its tributaries, also some artesian wells. The water flows and is pumped into 2 reservoirs at Aston. The 2 reservoirs are capable of holding 50 million gallons of water, and from them it is pumped by 6 steam beam engines (2 Cornish, 2 Baldwin, and 2 fly-wheel) through 2 22in. mains to a service reservoir, 265ft. above level of pumping well, capable of holding about 6 or 7 million gallons, and which is 3½ miles from pumps. From this reservoir a portion is pumped to another reservoir, distant about ¾ mile and 80ft. higher, which supplies the highest levels. The supply is constant, the pipes being always charged. Water closets are supplied from cisterns, (Dale's patent,) holding about 2 gallons. House connections are filled with Guest & Chrimes' ½-inch screw valve taps. About 8,000,000 are supplied daily.

Chessire's Intercepting Tanks.—At Birmingham I likewise saw in operation Mr. Chessire's intercepting tank.

The box is 2ft. 4in. long, 18in. wide, 18in. deep. The pipe from the privy or closet having a syphon trap above it, passes into the top of the box at the opposite corner to the outlet pipe, which placed at the bottom of the box is divided from the main part by a perforated grating, extending across the corner and the whole height of the box. The lid is

sealed with putty, and the outlet pipe is also trapped with a syphon trap. All the water, urine, etc. runs away to the sewer, the solid matter, paper, etc. being retained to be periodically removed. This appears to be a better form of cesspool, and may be worth trying in places that have no regular system of drainage.

LIVERPOOL.

I am indebted for the following statement to the kindness of JAMES NEWLANDS, ESQ., the Borough Engineer.

The area of the borough is 5,210 acres; of which there are occupied by buildings 4,148 acres, 2 roods, 23 perches, 725 yards; and unoccupied 1,061 acres, 3 roods, 16 perches, 23 pards. The length of streets is 221 miles,—of passages 90 miles. The length of street sewers is 189 miles 340 yards,—passage sewers 90 miles. The number of houses in the borough at the last census was—

	Inhabited 65,781	
	Uninhabited 5,197	
	Total 70,978	
The number of houses since built, to December 1868, is—	12,772	
Making the total ...		83,750
But Railways and Town improvements have in that time demolished a number, which may be estimated at		1,359
Making the probable total number of houses ...		82,391
The population at the last census was		443,938
Corrected for increase to this date (Sep., 1869), is now estimated by the Registrar General		509,052

The rateable value of the Borough is £2,412,672.

The water supply is obtained from 4 wells in and about Liverpool, which yielded in 1868 ... ... 2,085,088,693 gallons, and from Rivington Pike, which has a watershed of 10,000 acres and store reservoirs, which form spacious lakes, upwards of 6 miles in length, with an average storage of 3,180 millions of gallons, and from which were delivered in 1868 ... ... 3,436,922,208 „ making the total quantity supplied to the Borough and the district traversed by the pipes in that year ... ... 5,522,010,901 „

The population of the district of water supply is estimated at 600,000.

The annual consumption per head for domestic purpose was in 1868—24.38 gallons. The mean annual rainfall from 1848 to 1868 was 46.053 inches. The maximum was 61.70 inches in 1852. The minimum was 34.80 inches in 1865.

The water closet system is general, and will soon become universal. In the last 5 years 15,000 privies were converted into water-closets, and the work is steadily proceeding.

The quantity of Sewage estimated to be discharged from all the Sewers of the Borough is 2,100,000 cubic feet or 18,125,000 gallons in the 24 hours, say in round numbers 60,000 tons.

The annual rainfall in Liverpool may be taken at 35 inches, which would give 1,809,504 cubic feet in 24 hours. An amount nearly equal to the sewage proper.

VENTILATION OF SEWERS AND DRAINS.—In addition to the ordinary ventilation through untrappped drop-spouts, which has been the constant practice for the last 21 years, there has of late been an immense extension of ventilation by means of the Archimedean Screw Ventilator. Of these ventilators 1,030 have been erected and are now at work throughout the Borough.

High chimneys, furnaces, &c., in the line of sewers, are also connected with the sewers.

The utilization of the Sewage of one outlet is being experimented with by a Company.

The Test Works consist of a pumping station at Sandhills, with an engine capable of lifting 500,000 gallons 125 feet high in 24 hours; of about 9 miles of cast iron piping, 9 inches in diameter, extending from the station northwards to the Blundell Estate. The 9-inch pipe is provided with proper connections for delivering the sewage along its course. It terminates in a distributary pipe, carried through a piece of land containing 43 acres 1 rood 33¾ perchs, which has been taken on a lease by the Company.

Scavengering.—Report of the Superintendent of the Scavenging Department for 1867.—

The general scavenging, and the cleansing of middens and ashpits and everything connected therewith, was effected during 1867 at an actual gross expenditure of £65,010. The average strength of the staff employed on the scavenging day and night service has been—

	Day.	Night.	Total.
Inspectors	14	8	22
Trough Closets and Urinal Men	39	...	39
Scavengers	438	...	438
Night Men		106	106
Ashpit Men	40	...	40
Carters	77	80	157
Stable and Wharf Men	30	20	50
Total Men	638	214	853
Horses	80	80	160

As regards the results of the work done by the scavenging staff, in the cleansing and emptying of middens and ashpits, the sweeping of the streets, attention to urinals and trough water-closets, and the removal of all nightsoil. ashes, and scavenging products, they are represented by the following statement:—

Number of tons removed.

	Daily.	Weekly.	Total for the Year
Night service, contents of middens and ashpits...	446	2669	138,777
Day service, street sweepings, etc.	328	1963	102,065
	774	4632	240,842

I was also favoured with copies of the admirable reports of Dr. Trench, the Medical Officer of Health, from which I have extracted the following statements, which will show how vigourously Sanitation is carried in Liverpool.

The death rate of the Borough of Liverpool in 1868 was equal to 29.1 per 1,000 of the estimated population.

The average death rate of the Borough during the previous 10 years, (1858 to 1867,) was 32.2 per 1,000, or 3.1 per 1,000 more than in 1868. This is equiva-

lent to a decrease of 1,552 in the number of deaths relatively to the population, or in other words, it may be regarded as a saving of 1,552 human lives, when compared with the mortality of the previous decennial period.

The Registrar General's weekly reports enable us to compare the mortality of Liverpool with thirteen of the large Towns of Great Britain, but though such comparisons are desirable as incentives to sanitary improvements, they will lead to very fallacious conclusions if at the same time due weight be not given to the moral, physical, and economical conditions of the inhabitants. The amount of pauperism, of Irish immigration, and of unskilled labour in Liverpool, is far greater than in any other Town in the Kingdom, and no zeal in sanitary legislation can succeed in placing an indigent population in the favourable conditions of health, attainable by Towns whose labourers have constant work and are in receipt of remunerative wages; the density of population is also a physical condition which ought to be duly considered in every comparison of the results of sanitary work, and as this can be shewn directly, it has been included in two of the columns of the following table.

	Est. Population in the middle of the Year 1868.	Births in 52 weeks, ending Dec. 26, 1868.	Deaths in 52 weeks, ending Dec. 26, 1868.	Annual rate to 1000 of Population.		Area in Acres.	Population on Acre.
				Births.	Deaths.		
London	3,126,635	113,239	73,279	36.2	23.4	77,997	40.0
Bristol	167,487	6,057	3,800	36.1	22.7	4,674	35.8
Birmingham	352,296	12,689	8,394	36.0	23.8	7,831	45.0
Manchester ...	366,835	13,793	11,742	37.6	32.0	4,069	90.1
Salford	117,162	4,629	3,592	39.5	30.7	5,009	23.4
Sheffield	232,362	9,103	6,188	39.1	26.6	22,830	10.2
Bradford	134,000	4,931	3,537	36.7	26.4	6,590	20.3
Leeds	246,851	10,190	6,725	41.2	27.3	19,221	12.8
Newcastle on Tyne	127,701	4,860	3,232	38.0	25.3	5,336	23.9
Hull	122,628	4,243	2,984	34.6	24.3	3,621	33.8
Edinburgh	177,039	6,601	4,736	37.3	26.7	4,191	42.2
Glasgow	449,868	18,439	13,680	40.9	30.4	5,691	77.7
Liverpool	500,676	19,341	14,583	38.6	29.1	5,210	96.1

There are 2 disinfecting establishments in Liverpool where clothes and bedding are gratuitously disinfected; the number of articles sent to them during 1867 amounted to 16,639.

Slaughter house return of cattle killed in the Borough:—

Beasts.	Sheep.	Lambs.	Calves.	Pigs.	Goats.
49,331.	281,015.	20,889.	13,681.	32,474.	41.

Unwholesome meat condemned during 1868:—

Beef. lbs.	Veal. lbs.	Mutton. lbs.	Lamb. lbs.	Pork. lbs.	Poultry. head.	Rabbits. head.	Fish. lbs.	Shell-fish. bags.	Oysters. number.
80,927.	21,551.	14,466.	706.	5,385.	1,360.	1,639.	375,626.	384.	22,100.

Inspector of Nuisances' reports during 1868 :—

Complaints of nuisances made by inhabitants	1,953
Total number of nuisances reported by district Officers	40,601
Total nuisance notices	27,799
Number of informations	818
Number fined	165
Number withdrawn and acquitted	623
Magistrates' order	29

Fever in houses :—

1,283 Street houses examined, contained 2,172 cases of Fever.
667 Court „ „ „ 1,216 „
76 Cellars „ „ 80 „
Total number of cellars inspected, 66,284.

Proceedings :—

Number of cellar notices	3,068
„ „ informations	361
„ „ fines	251
„ „ „ acquitted and withdrawn	103

House to house visitation during 1868 :—

Total number of houses examined	131,101
Notices to white-wash houses	27,603

Fines inflicted for 1868 :—

Nuisances	£87	18	2
Diseased meat and slaughter houses	£17	2	0
Cellars	£26	3	6
White-washing	£31	2	6
Total	£162	6	2

PRESTON.

The following Statement is compiled from information kindly given me by R. Ascropt, Esq., Town Clerk, and by E. Garlick, Esq., Borough Engineer, and from extracts from the Municipal Corporations' Directory.

The Town is situated on the banks of the river Ribble. It is connected by Railways with all parts of England, and with the coast towns and manufacturing districts of Lancashire, and Yorkshire by the navigable river Ribble and the Lancaster Canal.

The chief trade is the manufacture of cotton fabrics; there are also iron foundries and machine works, and a small amount of shipping trade. Population is estimated at 97,000 persons, who reside in 17,241 houses. Its rateable value is £210,000: the area of the Borough is 2,819 acres.

Main drainage works have been executed at a cost of about £50,000. The main sewers extend for 25 miles, and there are 30 miles of sewers connected with them, paid for by owners. The large main sewers are brick and circular in shape, and the smaller ones brick, but eggshaped. These brick sewers extend for 8¾ miles, the remainder are made by stoneware pipes.

The sewers are ventilated through charcoal boxes and gratings into the street, and also through the down spouts, and are flushed by water laid on direct from the mains. All the houses are furnished with water-closets, and these are fitted with syphon traps. The house connections are 6in. and upwards: there are no cesspools known to exist: the sewers at present discharge into the river Ribble.

The present water supply is obtained from the Cowley brook, and streams in the south side of Longridge Fell (about 18 miles from Preston), which streams flow into the river Ribble above Preston. This water is conducted to the Spade Mill reservoir, which is capable of holding 110,000,000 gallons. Another source of supply is the Loud brook, which flows into the river Hodder, and thence into the Ribble. The water from this brook is conveyed to Alston reservoir by a conduit 4ft. diameter.

Alston reservoir is capable of containing 78,755,161 gallons; so that the total supply is 188,755,161 gallons.

The gathering grounds of these two sources of supply contain about 2,777 acres.

This supply has become inadequate for the requirements of the Town, as the demand for water in the Town and suburbs has gone on rapidly increasing; the demand for manufacturing purposes having more than doubled during the past 10 years. From these causes the Town has been short of water in the summer months; and for the scarcity of water and fear of running short for the domestic supply, the sewers in the Town have not been flushed, and the streets have been only partially watered, thereby causing great annoyance and damage from dust; and the dirty crowded courts and unhealthy portions of the oldest parts of the Town could not be cleared so effectually for want of water.

The quality of the Loud water is also very much complained of, so that the Corporation are about to expend £65,000 in procuring water from the valleys of the Langden and Handen brooks which are on the millstone grit, and where water of the purest quality is to be obtained.

The present supply is intended to be constant, and all houses are connected direct with the mains.

BLACKBURN.

The following Statement is compiled from information kindly given by F. Smith, Esq., Borough Surveyor, and by Mr. Whitehead, the Secretary of the Waterworks, and also from extracts from the Municipal Corporations' Directory.

Blackburn derives its name from the black colour of a rivulet which runs through the Town. It has ample railway communication with all parts of the country; and by means of the Leeds and Liverpool canal, with the ports of the eastern and western coasts.

The population is estimated to be about 80,000 persons, who live in 15,300 houses: the gross estimated rental is £225,000: the rateable value £182,000: and the area of Borough 3,681 statute acres.

The rates for highways and sewerage are 3s. 1d. in the pound; the poor rates are 3s. in the pound.

Main drainage works have been executed at a cost of £90,000.

There are 32 miles of sewers in main streets, and 19 miles of subsidiary mains. Of these, about 10 miles are composed of brick, eggshaped, and varying in size from 6ft. by 4ft. 8in., to 2ft. 6in. by 1ft. 8in. The rest are glazed earthenware socket pointed pipes, varying in size from 21in. to 9in. diameter.

Ventilation is effected through trays containing charcoal and placed at the end of each sewer.

The down spouts are connected direct with the sewers, with which also a few large chimneys are connected, and at the higher levels of the Town small shafts terminating in an Archimedean Screw at the top have been affixed to buildings. Special flushing arrangements are not considered necessary, as all the sewers have a good fall.

About 14,000 houses are drained with 9in., 6in., and 4in. glazed earthenware socket jointed pipes, which are all properly trapped, and connected with slopstone pipes, down spouts, and cesspools.

There are only 740 water-closets in Blackburn, and about 13,500 privies, and 6,700 cesspools, which latter are drained and kept dry; as a general rule there are 2 privies to each middenstead.

The present system adopted at the outfall is to let the sewage run through tanks, where the solid matter is retained, and the liquid runs into the river.

The Waterworks at Blackburn are in the hands of a private company. The water is drawn from streams, and from the rainfall collected over a large gathering ground. This is conducted into open reservoirs, which in the aggregate are capable of holding 454 million gallons. The lowest reservoir is about a mile from the Town, and about 220ft. above it. The water is brought in through an iron main 18in. diameter.

About 16,800 houses, in which from 75,000 to 80,000 people live are supplied with water, which is laid on day and night direct from the service pipe.

The water-closets are fitted with cisterns and ball taps; but Messrs. Guest & Chrimes' bib taps are used for house service.

The daily supply averages 1,400,000 gallons—a quantity equal to about 18 gallons per head. For domestic supply the charge is 6 per cent on assessment to poor rate.

MANCHESTER.

The following Statement has been copied almost verbatim from a report by Sir Joseph Heron, Town Clerk, with which I have been favoured by J. G. Lynde, Esq., Borough Surveyor. I have also incorporated an extract from Dr. Little's very valuable report, and from the Municipal Corporations' Directory.

There are about 250 cotton manufactories in the Town and Parish, some on scales of enormous magnitude for spinning, weaving, and printing, besides which there are bleach works, silk mills, and manufactories of every description of animal and vegetable fibre.

The City of Manchester comprises within the Municipal boundary the townships of Manchester, Cheetham, Hulme, Chorlton upon Medlock, Ardwick, and Beswick, containing a total area of 4,203 acres.

The population at census of 1861 was 338,722; it is now (1869) estimated at 370,000; the estimated number of inhabited houses is 73,000; the rateable value of the City amounts to £1,471,331 16s.

Sewage works have been constructed at a cost of about £340,000.

There are about 280 miles of main sewers in the City, and the area sewered is 3,235 acres. The main outfall sewers, varying in size from 6ft. by 3ft. to 3ft. by 2ft., are principally constructed of brick-work. The smallest sewers are glazed earthenware oval pipes, varying from 25in. by 18in. to 12in. by 9in. The inclinations generally are very good, varying from 1 in 30 to 1 in 300.

Nearly all the main sewers have such rapid falls that they do not require flushing; in special cases water is used from the nearest main. The only method of ventilation of the sewers adopted is through the down spouts of tho houses and the street grids which are untrapped. There are about 67,000 dwelling houses within the City, and it is estimated that there are only about 10,000 water-closets within the City, but there are about 3,800 privies with ashpits connected therewith: the Corporation does not permit any water to be thrown into these middens, which are systematically cleaned out by the Corporation at a cost per year of £17,668 10s. 4d., including carriage of manure to farmers, when about 130,987 tons are removed.

The sewers discharge into the rivers Irwell, Irk, and the Medlock, which are in fact only open cesspools, as they receive the refuse from the works on their banks, consisting chiefly of dye works, bleach works, paper mills, chemical works, bone works, tanneries, India rubber works, and slaughter houses.

The Water Supply is under the Corporation and is obtained from reservoirs made by damming up the river Etherow and its tributaries 18 miles distant from Manchester; the area of gathering ground is 18,900 statute acres, and the area of reservoirs is 601 acres, which hold about 4,582,000 gallons.

From these reservoirs the water is brought by mains to service reservoirs at Godley, Denton, and Prestwick, and from them the higher levels are supplied.

There is also a well sunk in the red sandstone rock at Gorton, about 5 miles from the City. This well is 12ft. in diameter and 210ft. deep, and the water is lifted by a Cornish engine into a reservoir capable of holding 223,000,000 gallons, and covering 57 acres. The maximum yield of this well was at the rate 750,000 gallons per day, which supply the lower levels. The area of district supplied equals 81 square miles, and on it are 108,419 houses, which are supplied for domestic purposes, and 9,416 works for trading purposes. The supply is constant, and a daily average of 13½ million gallons is supplied for domestic and trade purposes; 846,000 gallons are supplied per week during 4½ months of the year for watering the streets and for flushing purposes. Water for drinking is supplied to the houses direct from the mains, but for water-closets into cisterns.

The water-works have already cost about £1,780,000.

Copy of analysis by Dr. Angus Smith, of water supplied to Manchester:—

	In Grains.
Sulphate of lime	1.743
Sulphate of magnesia	.661
Chloride of magnesia	.555
Chloride of Sodium	.499
Iron, per oxide of	.145
Organic matter	.840
Total residue	4.515
Nitrates	none
Hardness	2°.

The death rate per 1,000 from 1857 to 1867 was

1857	31.7	per 1,000 of population.	
1858	32.5	„	„
1859	29.1	„	„
1860	28.0	„	„
1861	30.0	„	„
1862	30.3	„	„
1863	32.6	„	„
1864	30.6	„	„
1865	35.5	„	„
1866	34.6	„	„

The high death rate in Manchester is largely due to the excessive mortality in the infant population; nearly one half of all the deaths occurring in children under the age of 5 years.

The mortality at all ages is however abnormally great; consumption and the diseases of the lungs generally, especially bronchitis, are relatively to the population more fatal than in any other locality in England. This is probably due to a considerable extent to the constant irritation produced in the air passages by the dense smoke with which the atmosphere is constantly loaded. Zymotic diseases, including autumnal diarrhœa also largely swell the death rate.

BRADFORD.

The following Statement has been compiled from information given me by the Local Authorities; extracts have also been made from the Municipal Corporations' Directory.

Bradford is a manufacturing Town in Yorkshire, and has railway communication with the principal Towns in the Kingdom, and by means of a canal, has water communication with the Mersey and western coast, and the Humber and eastern coast of England.

The principal trade consists in the manufacture of woollen goods; and in the neighbourhood are extensive iron and coal mines, and several large iron foundries, dye works, soap, grease, and gas works.

Population by estimate, 1869, 138,000; inhabited houses by estimate, 1869, 29,280; rateable value, £504,192; gross estimated rental, £603,314; area of Borough, 6,508 acres.

£89,637 have been expended in works of main drainage; 21½ miles of main sewers have been already completed, and the work is still going on.

The brick sewers are eggshaped, from 15in. by 12in.: the smaller sewers are glazed earthenware pipes, from 8in. to 6in. Ventilation is effected through the rain-water pipes; there are also vertical pipes from the sewers, carried up to chimney stacks.

There are about 2,000 water-closets, and a large number of middens: the house connections are stoneware pipes, varying in size from 4in. to 9in.

The sewage at present is discharged into a Beck, which is a tributary of the river Aire, which it joins about 2 miles below at Shipley: this Beck has obtained an unenviable notoriety in Yorkshire from its excessive pollution, from, not only the sewage, but from the refuse cast into it from the various manufactories in the neighbourhood.

The annual rate of mortality has been reduced from 28 to 25 per 1,000.

The Water Supply is derived from various streams. The area of the gathering ground from which the water is brought is 21,000 acres, yielding from 10 to 12 million gallons per day for Town use, and about the same quantity as compensation water. It is stored in 11 reservoirs, occupying an aggregate area of 315 acres: other reservoirs and works are in progress. The supply is constant; and the house connections are direct from the mains. The annual rainfall is about 36in.

LEEDS.

The following Statement is compiled from various reports by Local Authorities, and from Dr. Robinson's report on the Sanitary Condition of Leeds, in 1867, and from a report on the best mode of obtaining an additional water supply by E. Filliter, Esq., kindly given to me by the Author; extracts have been also made from the Municipal Corporations' Directory.

The Town of Leeds is an important city in Yorkshire; it has railway communication with all parts of the Kingdom, and has water communication with Bradford, Liverpool, and other places, by means of the river Aire, the Aire navigation, and the Leeds and Liverpool canal.

The woollen manufactures of Leeds are very extensive; in addition to which, the working of iron is being rapidly developed; and there exists also numerous dye works, tanneries, chemical works, beside factories for a great variety of purposes.

The area of the Borough, comprising 12 townships, covers about 34 square miles. The population within the limits of the Borough is (1869) estimated to amount to about 250,000 persons: the rateable value is £678,514.

Main drainage works have been executed at a cost of about £180,000. There are about 100 miles of main sewers: the smaller ones consist of glazed

earthenware pipes 12in. diameter, and the larger ones are eggshaped brick sewers, varying in size from 2ft. 6in. by 1ft. 9in. to 7ft. 9in. by 8ft. at the outfall.

There are about 47,000 houses, but only 7,000 water-closets: there are about 12,000 middensteads or ash privies, about 1,000 of which are situated under dwellings. The Corporation undertakes the cleansing of these middens, at an annual gross outlay of over £7,000.

The sewers discharge their contents into the river Aire, which is still further polluted by the refuse and waste products of the various manufactories situated on its banks.

On the assumption that the population was 232,428, the death rate in 1867 was 26.9 per 1,000, during 1865 it was 30.9, and 32.3 during 1866. Out of 253 deaths from Fever, 93 instances were attended with marked sanitary defects, consisting either of defective drainage, or offensive cesspits.

Amongst the various sanitary operations carried on, the following summary exhibits some of the work accomplished during 1867:—

Cottage houses visited with a view to improve their sanitary condition	3,509
Houses disinfected where contagious diseases had occurred	516
Over-crowded houses partially emptied	147
Cellar dwellings closed	33
Offensive middensteads, under or immediately adjoining houses, converted into water-closets	128
Pigsties removed	125
Orders made by Magistrates	45
Miscellaneous other nuisances removed	4,604
Notices and letters issued	7,657

A self-acting tumbler flushing apparatus has been successfully applied to water-closets in the poorer districts, especially in cases where the privies are used by more than one family.

The scavenging of the city is performed by men employed by the Corporation, the contract system having failed; and owing to the unsatisfactory way in which the night scavenging was performed by the Contractors, the Corporation has also undertaken the cleansing of the ashpits. From April 13th to Dec. 31st, 1867, 14,991 ashpits were emptied, containing 45,307 tons of manure, at a cost of £7,487: the sale of manure, however, amounted to £4,183, which materially reduces the gross cost.

Mr. Filliter's Report.—

The present supply of water is derived chiefly from the river Wharfe, at Arthington, and partly from the small gathering ground about the Eccup reservoir with certain springs near thereto. Altogether there is a total available quantity in a dry year of somewhat under 7 millions of gallons per day, and in an ordinary year of somewhat over 7 millions of gallons per day.

The source of present supply is open to suspicion of contamination by the sewerage of Otley, Burley, Ilkley, and Addingham, and the refuse of the paper, worsted, and other mills, and works on the Wharfe and its branches, above the point at which the water is pumped.

The conclusions arrived at in the report are thus summarized:—That the new source should be one capable of affording a supply of about 20 millions of gallons per day.—

That the hardness of the water should not exceed if possible 4 or 5 degrees.—

That the river Washburn is capable of affording this quantity and quality of water chiefly by gravitation, but assisted in dry weather by pumping from the foot of the Washburn; the water for this purpose being conveyed by pipes, laid thence to the present works at Arthington.—

That the cost would be about £317,000; other suggestions are made, but the one above has been adopted, and is in course of construction.

The use of cisterns in water-closets is compulsory; and MESSRS. GUEST & CHRIMES' fittings are recommended.

PENRITH.

A small Town situated in Cumberland. Its population amounts to 7,948 persons, who live in 1,721 houses: the gross estimated rental of the district amounts to £37,249.

Main drainage works have been executed, at a cost of about £5,000. The sewers consist of stoneware pipes, varying in size from 6in. to 15in. They are ventilated chiefly through the rain-water pipes; and are flushed partly from the water mains, and partly from the Beck, which runs through the Town.

THE WATER SUPPLY is derived from the river Eamont, the overflow of the Ulleswater Lake, from whence it is pumped into a reservoir, and brought into the Town.

The sewage is applied to meadow land. This meadow is situated between the rivers Eamont and Louther just above their confluence; and the sewage is conveyed through an iron main under the river Eamont, and flows through open stoneware carriers on a raised embankment, and is distributed through open trenches to such parts of the meadows as may be desired.

At its outfall into the main carrier it is received into a small tank, where, by a simple arrangement, it is made to mix with carbolic acid.

The use of carbolic acid is strongly advised by the lessee of the meadow, MR. MAC DOUGALL, the inventor of MAC DOUGALL'S carbolic acid disinfectant. He states that by its use, flies are driven away; and that this is a matter of some importance, as the meadow to which the sewage is applied is immediately in front of, and distant about a quarter of a mile from a gentleman's house. The grass of the meadow is grazed by cattle, who thrive very well on it.

The effluent water passes off into the 2 rivers. No complaints have arisen from the owners of property on either side.

CARLISLE.

The following Statement has been drawn up from information supplied, and copied from a report written by EDWARD MORLEY, ESQ., City Surveyor; and extracts have also been made from the Municipal Corporations' Directory.

The City of Carlisle is placed on a slight eminence at the confluence of the Rivers Eden, Caldew, and Peteril.

The principal trade consists in the manufacture of woollens, coarse linen cloth, calico printing, and cotton piece goods; there are also iron foundries, breweries, and tan yards.

Population, 1861, 29,417, estimated 1869, 31,000; inhabited houses, 5,140; estimated number of electors, 4,000; burgesses, 3,500; rateable value, £88,000; area of borough, 1,525 acres; municipal income, £27,000. Main drainage works were executed in 1853—1855 at a cost of £23,000.

About 20 miles of main sewers have been constructed, consisting of brick sewers, iron and earthenware pipes, varying in size from 3ft. 9in. by 2ft. 6in., down to 9in. diameter. They are ventilated by connections made with tall chimneys, and through charcoal ventilators into the streets, and through the down spouts, and are flushed by water from the streams, and by chambers especially constructed for the purpose. Every house in the Town is connected with the sewers, by circular 9in. or 6in. diameter pipes: no cesspools are allowed: the sewage is partly utilized in irrigating the land, and is partly delivered into the river Eden.

The scavengering is performed by the Board's own workmen, though the horses used are supplied by a Contractor: the annual cost of scavengering is £855.

Sewage Irrigation Works.—The site of these works is situated about $\frac{5}{8}$ of a mile from the market-place, in a north-easterly direction from the City, and is surrounded on three sides by the rivers Eden and Caldew, and on the fourth side by the North British and Caledonian Railways.

These works were designed and constructed by Mr. H. W. Mc Kie, in the year 1860, at that time City Surveyor, on behalf of Mr. A. Mc Dougall, of Manchester, who leased the whole of the sewage of Carlisle for a term of 15 years, for the nominal rent of £5 a year.

The total population is about 31,000; but the whole of the sewage is not at present used for irrigation, owing to 1 district containing 9,500 inhabitants delivering its sewage into the main outlet sewer below the site of the engine works.

A 4-horse power engine, working one of Gwynne's centrifugal pumps, lifts the sewage from a well in connection with the main outlet sewer, to the height of about 12ft. and delivers it into an open trench, constructed along the side of the river embankment, with an inclination of 1in. in 1,100: the sewage is then distributed where required by means of moveable iron troughs, 12in. by 8in. Previous to pumping, the sewage is deodorized by lime water and carbolic acid, in the proportion of 1 gallon of the fluid to 40,000 gallons of sewage, at a cost of about £25 per annum.

The sewage is distributed over the whole of the lands, in extent about 110 acres, about 4 times a year. The subsoil of the land is sandy and very porous, allowing water freely to percolate, and is laid down in ordinary pasture, and is entirely grazed.

Mr. Mc Dougall has sublet the whole to an extensive sheep farmer and butcher in the Town. The cost per acre is about £10 per annum, including all working expenses: the value of the land previous to irrigating was about £4 per acre, and is now let at £8 per acre.

The natural grasses have not been made any coarser through the irrigation works, but have increased in firmness and quality; and the sheep and cattle eat it readily.

It has been stated that the patients in the Lunatic Asylum have been made ill from this irrigation, but it is altogether a mistake.

The meadows immediately adjoining the Asylum were being irrigated in a very crude manner by the sewage from the Asylum; and the medical officer stated that the patients were afflicted when the wind blew over the Asylum meadows in a certain direction.

The distance between the Town irrigation meadows and the Asylum is 3 miles as the crow flies; and the whole of the Town lies between, at a distance of only $\frac{1}{2}$ a mile from the works; and if there had been any truth in the assertion, it is natural to suppose that the inhabitants of the City would have suffered.

In Mr. Mc Dougall's lease, a clause is inserted "That should any nuisance arise, the Corporation shall be at liberty to break the lease without any compensation;" but up to this time there has not been a single complaint, although the site of the works is surrounded by the castle and several villas.

Water Supply is obtained from the river Eden, from whence it passes through an open filter, which has been constructed on—what I am informed is termed—the Scotch plan: this plan is not approved of, and they are now altering it to the usual English one.

The engine house is situated on a slight eminence, at about 1,400 yards from the river Eden. The water is pumped from here to a reservoir, a distance of

about 2,200 yards: this is capable of holding about 2½ millions of gallons. It is about a mile from the centre of the Town, and its top water level is 41ft. above the highest part of the Town, and 84ft. above the lowest part of the Town: the service is constant, and no cisterns are permitted, the house service being laid on direct from the mains.

The above structural works were performed with money borrowed in loans; principal and interest to be repaid in 30 years.

HEXHAM.

The following information has been for the most part kindly supplied me by WILLIAM ROBB, ESQ., Chairman of the Public Health Committee.

Hexham is a small Town in Northumberland, situated on an eminence rising in the valley of the Tyne.

The population according to the census of 1861 was 5,270, and it is estimated that there has been no great increase since; inhabited houses amount to 525 ; gross estimated rental, about £21,000; rateable value, £18,496 15s.; main drainage works have been executed at a cost of nearly £5,000.

They extend over a length of 4 miles, and consist of glazed earthenware pipes, varying in size from 18in. to 9in. Flushing is effected from hoses attached to the street hydrants, and ventilating shafts open into the streets protected with charcoal trays. Every house is connected with the sewers; but there are only 230 water-closets in the Town. No cesspools exist, but there are a few middens which are however kept dry ; at the outfall there is a brick elliptical formed sewer of about 200 yards long; through this the whole of the sewage flows into depositing tanks, which are in duplicate, where the solid matter is partially deposited and from which the sewage flows into the river Tyne.

These depositing tanks are periodically cleaned out and the contents mixed with Town street refuse and sold to farmers at about 1/- per ton.

The water supply of Hexham is gathered from a reservoir on the side of the hill above the Town, where an embankment has been thrown across a valley into which spring water flows. The reservoir which is open, is capable of holding 20 million gallons of water.

The water is conveyed through an iron main 12in. in diameter into the Town, and distributed through mains varying from 12in. in size to 3in. in diameter.

The supply is constant and nearly every house is supplied direct from the mains,—no cisterns are allowed.

The scavengering of the Town is done by the Board.

The permanent works were performed out of monies borrowed, repayable for the most part in 30 years, at 6½ per cent per annum, meeting both principal and interest. The remainder was borrowed at 5 per cent on debenture.

Since these works of water and sewerage were finished in 1865 the death rate has been reduced from 27 per 1,000 to 22 per 1,000.

SUNDERLAND.

The following statements has been compiled from information given me by WM. SNOWBALL, ESQ., Town Clerk of Sunderland. Extracts have also been made from the Municipal Corporations' Directory.

Sunderland is an important Town in the county of Durham, and is situated on sloping ground abutting the sea, or the south bank of the river Wear.

Sunderland and Newcastle are the two largest coal shipping ports of the United Kingdom, and besides the immense ship building docks of the former,

(second only to Liverpool for the number of ships of small burthen annually launched,) it enjoys an immense export trade in glass, rope, chains, anchors, and other ironwork, earthenware, etc., etc.

The population is estimated at 85,000, who live in about 10,000 houses: the gross estimated rental is £300,000, and the rateable value, £250,000, and the area of the Borough is 2,768 acres.

Main drainage works have been executed at a cost of £163,000.

The sewers are made of brick and earthenware pipes: the brick ones are eggshaped and vary in size from 4ft. by 2ft. 8in to 2ft. 10in. by 1ft. 10in., and the pipes from 18in. to 9in. The sewers extend over about 80 miles and their contents are discharged into the river and into the sea; they are ventilated through connections with the factory chimneys, and are flushed with water taken from the mains.

The Water Supply is into the hands of a private Company who have extensive works at Humblet on-Hill, Pulwell, Cleadon, and Ryehope. At these places the water is raised from artesian wells, sunk and bored into the limestone rock, and it is stated that the storage capacity of the several reservoirs equals 8½ millions of gallons; the daily supply which is on the constant system equals 3½ to 4 millions of gallons. Houses are supplied direct from the mains; about 3,000 water-closets are supplied, and each one must be fitted with double valve cisterns. Messrs. Guest & Chrimes', and Lambert's fittings are used.

Not only Sunderland but South Sheilds and Jarrow are supplied by this Company.

ALNWICK.

This statement is made from information kindly given me by R. Elliot, Esq., the Town Surveyor.

Population of District about 7,000.
of Town about 6,000.

The whole Town is sewered with glazed earthenware pipes, varying in size from 18in., 15in., 12in., 9in. to 6in. pipes. The main sewers is laid on a gradient of 1in. in 400in. and discharges into the river Alne about 1½ miles below the Town. The street mains generally have a good fall; there are two flushing chambers, and the sewers are flushed once a fortnight from hydrants. Ventilation is chiefly effected by rain water down pipes which are carried above the windows. There are about 1,000 water-closets connected with the sewers; these are all fitted with a syphon trap: there are also about 1,500 trapped sinks. The house connections are 6in. pipes.

The sewers carry off about half the rainfall, the other half is taken in at storm gullies and carried in conduits to the river.

The Water Supply is obtained from various springs, the farthest of which is 2½ miles from the storage reservoir, to which the water is conveyed through glazed earthenware pipes. Before it reaches the reservoir however the water passes through a filter made of the usual form and composed of broken stones, gravel, and sand which are 4½ft. deep in the aggregate. The storage reservoir is about ¼ of a mile above the Town, is covered, and capable of holding about 220,000 gallons when full. It stands on a considerably higher level than any part of the Town, and would give a mean head of 150ft.

The supply is generally constant, but in seasons of long draught it is necessary to cut it off for a few hours during the day.

It is distributed through iron mains of the following sizes:—9in., 6in., 4in., 3in., and 2in.; there are however very few 2in. pipes as they are considered to be

too small. The house supply both for water-closets and other purposes come direct from the mains. Messrs. Guest & Chrimes' taps and fittings are used.

The iron mains were coated inside and outside with Dr. Smith's solution, and after 15 years there is not the slightest corrosion; the branches are galvanized iron.

BERWICK ON TWEED.

The following Statement is compiled from information supplied to me by James Weddell, Esq., Clerk to the Local Board, and from extracts from the Municipal Corporations' Directory.

A seaport Town, carrying on a considerable coasting trade with London, Edinburgh, Newcastle, Hull, etc., by means of steamers and sailing vessels. The chief exports are fish, corn, whisky, and coal: the chief imports—iron, timber, flax, hemp, and tallow. There are extensive iron works for constructing steam engines and mill castings, and slips for the repairs of vessels.

Population of the Borough, 13,303. The Borough includes the adjoining townships of Tweedmouth and Spital; but these townships have not been drained or supplied with water by the Local Board of Health. The population of the Town of Berwick, which has been drained and supplied with water 8,571. Gross estimated rental of that part of the Borough assessable to special district rate drained and supplied with water, £18,500; rateable value, £16,500.

The main drainage carries off both the storm water and the sewage, and has its outfall into the river Tweed.

The main drains are brick, circular, sewers varying from 2ft. 6in. at outfall, to 18in. at the upper levels, and extend over a length of 6,353 yards: the subsidiary drains are glazed earthenware pipes, varying in size from 15in. down to 9in.

Ventilation is effected by shafts (metal pipes) which are carried to the tops of houses, where there are blank gable ends; and also through the down spouts and manholes.

The sewers are flushed by metal pipes connected with the water mains, let into special flushing chambers, and at the dead ends of sewers. There are no cesspools in the Town; and there are 693 water-closets, which are all syphon trapped, size of soil pipe, 6in., pipe from sinks and kitchen, 4in.

The scavengering of the Town is performed under the direction of the Local Board of Health, who have their own plant, and employ the requisite number of labourers.

The drainage works were executed at a cost of £6,182 15s. 11d.

The average annual mortality rate per 1,000, during the 10 years prior to the completion of works of sewerage and water supply—25.3 per 1,000,
During the subsequent 8 years—23 „

Water Supply is obtained from a reservoir, formed by an embankment thrown across a valley, about 3 miles from the Town: this reservoir covers about 5 acres, and is calculated to hold 8,500,000 gallons. From this reservoir the water gravitates to a service reservoir, which is about 300ft. above the lowest part of the Town, and holds 250,552 gallons of water; from thence it is conveyed by a 12in. pipe into the Town.

Unfortunately, several years after construction, the service reservoir has been found to leak, and the towns-people are put in dry weather to the very greatest inconvenience: the supply which was calculated to yield about 30 gallons a head to each individual, has dwindled down in dry weather to only 36,000 gallons during the day, or a little more than 4 gallons per head. During August, 1869, the average supply was 51,000 gallons per day.

Of course under these circumstances the supply is necessarily intermittent.

The Waterworks cost £8,218 1s. 5d.

EDINBURGH.

The following Statement is compiled from extracts copied from the extremely valuable reports of CHARLES MACPHERSON, ESQ., Borough Engineer, and of DR. LITTLEJOHN, F.R.C.S.E., Medical Officer of Health for the City.

The greater part of the City of Edinburgh is built on the slopes of 3 ridges, lying nearly east and west, and parallel to each other: the High Street and Canongate being on the centre ridge, George Street on the northern, and Heriot's Hospital on the southern.

The drainage of the City is naturally to the Firth of Forth by three main outlets, namely,—

1.—The Craigentinny Burn draining the area which includes the slopes on each side of the centre ridge and opposite slopes.

2.—The water of Leith draining the area which includes the slope northward of the north ridge; and

3.—The Jordan or Powburn, which receives the drainage of the slope southward of the south ridge.

Between the years 1778 and 1825, about 19½ miles of sewers were constructed, at a cost of about £69,000.

The size of the sewers then laid down is generally 5ft. 6in. by 3ft. The branch drains for collecting the refuse from kitchen sinks, water-closets, etc., were generally imperfectly constructed with rubble stones, side walls and pavement sills, and covers. In the course of the branch drain a built cesspool was invariably formed, the evil arising from which, has been forcibly pointed out by DR. LITTLEJOHN, and the substitution of syphon traps recommended.

From 1825 to 1853 little seems to have been done in regard to sewerage; but since 1853 about 20 miles of sewers have been constructed, of which, above 5 miles are built sewers, above 3 miles are pipe sewers above 12in. diameter, and the remainder are pipe sewers 12in. diameter or less. The cost of these works has been nearly £50,000.

Edinburgh is pre-eminent for its arrangements for the removal of solid refuse, 50,000 tons of which are annually collected and sold for manure. The inhabitants are compelled by the Police Act to bring all household refuse to the streets, and 65 carts or wagons are employed in the removal of it from the Old Town and poorer districts in the morning and evening, and from the New Town in the morning.

Eight overseers and 135 scavengers are employed under the Inspector of Cleaning in these operations. The scavenger after filling the cart, sweeps up any refuse that may have been left in the streets, and conveys it to covered dust boxes, provided in various parts of the City, which are cleaned daily.

These dust boxes are 8ft. long, by 4ft. broad, and 6ft. high to the eaves, with a sloped roof, and entrance is obtained by a door about 3ft. wide.

The cost of the whole cleaning arrangements, including implements, collection of rates, etc., etc., amounted in 1866 to £17,268; but as the manure sold for £8,072, the actual cost to the City was £9,556. The cartage of the refuse is let to a Contractor, the collection of it being the work of the scavengers.

The greater part of the dry refuse consists of that from dwelling houses, namely, ashes, vegetable matter,—such as potato peelings, cabbage leaves, etc., animal matter resulting from the cleaning of fish, fowls, etc.; and there are also the horse droppings, and other impurities collected from the streets by the scavengers.

The mud from the macadamized roads is not mixed with the manure.

Besides the ashes obtained from the poorer neighbourhoods there is some excrementitious matter. After the ashes and refuse from the streets have been taken to the wagons, the excrement from the public conveniences, of which there are 26, amounting to about 7 tons daily, is then added.

This refuse is sent out of the City by three lines of railway and by the Union Canal; or in the event of there being no demand for it at the time by any of these routes, it is taken to 2 depots, situated beyond the outskirts of the City.

Application of Sewage to Irrigation.—The waters of the Craigentinny Burn, the Lochrin Burn, the Jordan Burn, and the Broughton Burn, are used in irrigating about 336 acres of land adjoining them; and the following is a description of the details of the management of the meadows irrigated by the Craigentinny Burn:—

The area within the City, draining towards it, is about 1 square mile and a half in extent. From this district there flows about 20 cubic feet of spring water per minute; the surplus rainfall being the non-absorbed portion of 24in. per annum, and the sewage from a population of 95,589 persons according to the census of 1861, with a water supply—say of 25 gallons per head. Of this population, about 60,000 have the use of water-closets, and the excrementitious matter from about 15,000 or 20,000 of the remainder, finds its way to the sewers connected with the Burn.

The sewage emerges from the sewer at Clockmill Bridge, and from this point till it reaches the sea near Portobello, a distance of fully a mile and a half it is used for the irrigation of lands adjoining the stream.

Various kinds of soil are irrigated: the subsoil of the part of the meadows nearest the City is peat with loam over it, near the course of the Burn; while to the northward it is naturally sand; but the sand has been taken away, and the ground made up with rubbish of buildings, dressed off with soil. Further down the course of the stream, the soil is reddish clay or loamy clay, or sandy clay; while at the part of the Figgate Whins adjoining the sea shore, it is pure sand, with a coating of rich loam, varying from 1in. to 4 or 5in. deep, entirely derived from repeated applications of the sewage, no soil having ever been spread over the sand.

The deeper soil is nearest the channels for conveying the sewage to the land. The meadows in the Farm of Loch End, at Restalrig and at Craigentinny, have a slope transversely to the course of the stream, varying from the steepest part 1 in 55, which is of small extent, to about 1 in 50, which is the slope of the greater part of the meadows. The Figgate Whins were artificially levelled to allow of irrigation.

The ground has been dressed, so as to have a regular slope transversely, from the course of the stream up to artificial channels, called feeders, about 18in. wide by 6 or 8in. deep, formed round the ground to be irrigated: these feeders have been formed with only fall enough to cause the sewage to flow slowly along them.

At intervals of from 30 to 45 yards, channels about 12in. deep and 6in. wide, are formed from the bywash to the feeder, thus disposing of the ground into panes or square plots of about ¾ of an acre each: the irrigation of these plots is a separate operation.

The sewage can be turned into the feeders as required; and the irrigation of any particular plot is effected, by stopping up the feeder where it passes the lower end of the plot, until it becomes full of sewage, then, by small notches on the top of the bank forming the feeder about 3ft. apart the sewage is drawn off from the feeder, and overflows the ground in minute streams, the number of which may be increased or diminished at pleasure. At some places in the flat ground, the transverse channels convey the sewage down each side of the plot, and from them it is drawn off by a number of smaller channels.

The point aimed at is to have the ground so disposed that the sewage shall flow equally, if possible, over the whole surface.

The irrigation is begun in the month of February, when about a quarter of an inch in depth of sewage is allowed to flow over the ground for 24 hours. Ten days afterwards, the same quantity for 12 hours; and a third soaking is given in another 10 days, care being taken not to soil the partially grown grass by the latter operation. This is the whole process, repeated once for each crop, of which there are generally 4 per annum.

It is important to remark that the land, except the sand at Figgate Whins, has been drained thoroughly, to a depth of 4ft. below the surface. It was found that with

shallower drains, the sewage was drawn off by the drain, leaving the lower part of the ground without irrigation. At the Figgate Whins, the sewage soaks into the sand and oozes out upon the sea shore.

The kind of grasses grown are Italian rye grass and meadow grass. The rye grass requires to be re-sown every third year; but the meadow grass has not required re-sowing, not even on the Figgate Whins, which was sown about 40 years ago, when the ground was first irrigated.

The irrigated ground is let off in small plots or squares for the season, to the highest bidder: the grass is cut by the tenants as required. An average crop is considered to be from 30 to 40 tons per acre, in 4 cuttings.

The whole grass is eaten by 3,100 cows; but after the fourth crop is cut, sheep are turned on for about a fortnight. The sheep do not seem to thrive, however, although the food is plentiful: the grass has been found most suitable for feeding cows; the attempt to use it for feeding other animals having been found not to answer, and the cost of converting it into hay being proved to be such as to render the process unprofitable.

The price paid for the plots varies considerably; the best being known to bring £40 per acre, while others are as low as £15 to £20.

The rental of the Figgate Whins previous to irrigation, was about 20s. per acre; while, when irrigated, parts have been let for some years at £40 per acre.

In no case is the whole of the sewage of any of the streams absorbed; and no irrigation is carried on from September till February, except at the Figgate Whins. During this time, the whole sewage passes to the Firth of Forth without being used.

The Water Supply of Edinburgh is in the hands of a private company; and the water is derived from the Crawley and other springs. In 1863, the daily supply amounted to 31 gallons for each inhabitant; but it is expected that this amount will be increased to 39 gallons per head. The service is constant.

There are 49 public wells and 20 drinking fountains distributed throughout the City. An enormous waste of water is complained of, as taking place through the faulty construction of the ordinary watercocks; and the construction of the water cisterns, and their connection with the drains is also complained of.

The City has been divided into 19 sanitary districts,—7 of which constitute the New Town; 9 the Old Town; and 3 form the Southern Suburbs.

The district of Landward, although not within the Municipal boundary of the City, has been included in the reports of the Registrar General under that of Edinburgh.

In the table below are given the population of the 3 divisions, as at the census of 1861; their respective mortality during 1863; their acreage; and the density of the population.

	Population, 1861.			Mortality, 1863.			Death rate per 1,000.			Area in Imperial Acres.	Propor. of Pop. to each Acre.
	Above 5 Years.	Under 5 Years.	Total.	Above 5 years	Under 5 years	Total.	Above 5 years	Under 5 years	Total.		
New Town ...	55,084	5,519	60,603	741	368	1,109	13.27	66.67	18.3	1765.5	34.3
Old Town ...	85,187	12,901	98,088	1,618	1,397	3,015	18.99	108.29	30.73	1078,5	90.9
Southern Suburbs	8,513	917	9,430	146	46	192	17.15	50.16	20.36	1104.	8.5
Total for Parliamentary Area	148,784	19,337	168,121	2,505	1,811	4,316	16.83	93.65	25.67	3948	42.5
Landward ...	2,130	193	2,323	85	11	96	29.9	57.	41.32	3127.	.7
Total	150,914	19,530	170,444	2,590	1,822	4,412	17.16	93.29	25.83	7075	24.1

Edinburgh has never been considered an unhealthy City. It is, however, peculiarly exposed to the ravages of epidemic diseases of all kinds, on account of its dense and badly housed population; and whether the epidemic be cholera or fever, the poorer inhabitants living in the crowded districts of the Old Town, suffer in a marked degree.

The following table shews the average death rate for the 5 years, ending in 1863, to have been only 24 per 1,000. It will be observed that the population has been calculated for each year, and that certain deductions have been made for the number of deaths, viz:— those of persons who died in the Royal Infirmary, and were belonged to Leith, or to various counties of Scotland.

By this means a correct estimate can be formed of the death rate of the City, which would otherwise be burdened with a large amount of mortality, for which it is solely indebted to the celebrity of its Hospital and Medical School.

YEAR.	Pop. within the Parli-mentary Boundary.	Total deaths Registered within the Par. Boun.	Deduct deaths belonging to		Remain-ing Mor-tality.	Births.	Death rate per 1,000.	Birth rate per 1,000.	Excess of birth rate over death rate.
			Leith.	County.					
1859	166,380	3,619	23	86	3,520	5,446	21.09	32.73	11.64
1860	167,248	4,149	22	97	4,030	5,380	24.09	32.16	8.07
1861	168,121	4,077	23	108	3,946	5,694	23.47	33.87	10.4
1862	168,989	4,661	19	137	4,505	5,722	26.65	33.86	7.21
1863	169,857	4,496	31	149	4,316	6,122	25.4	36.05	10.65
						Average	24.15	33.74	9.59

GLASGOW.

The following Statement is compiled from extracts from various reports, kindly given me by Dr. Gairdner, the Medical Officer of Health of Glasgow; and from the report on the Vital Statistics of Glasgow, by Wm. West Watson, Esq., the City Chamberlain; and from the report of Messrs. Bateman & Bazalgette, on the Sewerage of Glasgow, and the Purification of the river Clyde.

Mr Watson's Report.—

The City of Glasgow, including Gorbals, lies on both sides of the river Clyde, and the population within the Municipal boundaries is estimated to have been, in the middle of 1868, 447,000 persons; basing the calculation upon the average family ratio, which was found to exist in 1861.

Inhabited dwelling houses, 93,393, taken at 4.72—440,814
Inmates of public Institutions, barracks, and seamen in harbour, say— 8,186

Total population within Municipal boundary 447,000
Population in the suburbs 69,565

Total estimated population of the City of Glasgow, inclusive of suburbs 516,565

The births and deaths ascertained to have been registered in 1868, are represented by the following ratio.—

Births ... ... 41.63 per 1,000
Deaths ... ... 30.928 „

The following abstract shews the entire rental of Glasgow during 1868-69 :—

Houses, shops, warehouses, factories, gas, water, and other works	£1,904,092
Railways and canals	£40,536
	£1,944,628
Royalty beyond Borough—houses, shops, etc. ...	£30,738
Railways and canals ...	£11,580
	£1,986,946

The area of the Borough is 5,063 acres : the average number of persons to an acre, was in 1861, .78

From Messrs. Bateman & Bazalgette's Report.—

Compared with most English Towns, the City of Glasgow covers a small area, in proportion to its population. The land on which the City stands rises rapidly on the north bank of the river Clyde: the higher parts of the Town attaining an elevation of about 200ft. above the sea. On the south side, some low level ground occupies a narrow belt adjoining the river, from the southern margin of which, the ground rises to an elevation about 100ft. above sea level.

Several Burns,—the Camlachie Burn, the Molendinar Burn, St. Enoch's Burn, and the Pinkston Burn, together with the more important stream of the river Kelvin, cut up the sloping ground on the north side of the river, into a succession of ridges and valleys, which rather facilitate than hinder the convenient sewage of the City.

On the south side, the ground is more uniform in level no Burn or stream of any importance occurring within the area occupied by buildings.

The City itself on both sides of the river possesses great facilities of good drainage, which have been carefully and judiciously taken advantage of, and the City may be considered, therefore, as being thoroughly well drained. For the greater part, the sewers have short and rapid runs, and flow direct into the river. The extensive introduction of water-closets, together with the refuse of many distilleries and chemical works, swell the volume of the sewage beyond that of most Towns, and increase its offensiveness.

Received into the river, it stagnates and putrifies in the harbour, poisoning the air, injuring the health of the residents, acting destructively on the sheathing of vessels in the harbour, annoying all travellers by steamboat, and no doubt injuring the trade of the port.

Messrs. Bateman & Bazalgette in their report, (from which, space will not permit me to make further extracts,) propose to intercept all the sewage of the Town and to carry it by a culvert exceeding 27 miles in length to the sea coast of Ayrshire, to be utilized in irrigating the sandy land of the coast. They estimate that not less than 8,000 or 9,000 acres would be required for this purpose, and the probable gross outlay, if this scheme were carried to completion would amount to £1,253,256.

There are at present upwards of 70 miles of main drainage in Glasgow; the sewers are composed of brick and are egg shaped; they vary in size from 2ft. to 5ft., and are ventilated by the rain water spouts, and through gratings and manholes. No especial arrangement have been made for flushing them.

The house connections are laid in pipes varying in size from 9in. to 12in. in diameter.

The water-closet system is not universal in Glasgow. In the report of the engineers above quoted, it is mentioned that out of the 90,000 families of which the population of Glasgow is estimated to consist, 40,000 are without water-closets.

The City has been divided by Dr. Gairdner into 54 sanitary districts, which are under the medical inspection of six Medical Officers of Health, Dr. Gairdner supervising the whole.

The Medical Officers of Health order tenements to be fumigated and white-washed, articles of clothing to be disinfected, bedding of fever patients to be destroyed, and replaced, closes, streets, lanes, and gutters to be flushed with water, besides inspecting tenements let in lodgings, and seeing that the terms of the law regarding over-crowding are carried out.

Sanitation is also vigorously carried out by the Improvement Committee, who are doing a vast amount of good, in pulling down and re-constructing houses in the most densely populated quarters of the Town: the over-crowding in some portions of which exceeds that of the worst parts of London.

The cleansing of the City is performed under the Board of Police of Glasgow.

The average number of men employed during the year was as follows.—

In the scavengering department—including street sweepers, cleaners of private streets and courts, broom makers, fumigaters, washers, etc.	392 men.
In the manure department	346 „
Average Total	738 „
Horses employed	118 horses.
Total railway wagons belonging to the City	250 wagons.

The total quantity of manure collected:—

	Tons.	cwt.
By night service, contents of middens and ashpits	97,237	1
„ day „ street sweepings	42,002	12
Remaining on hand	6,351	0
Total	146,590	13

During the same period the following quantities of manure have been despatched:—

	Tons.	cwt.
By rail, 15,193 wagons at $6\frac{14}{20}$ per wagon	101,635	13
By canal	6,878	0
By farmers in their own carts	35,420	11
	143,934	4
Stock of manure on hand	2,656	9
Total	146,590	13

The total expenditure on these operations amounted to		£41,729 3s. 6d.
But from this has to be deducted sale of manure	£21,001 4s. 9d.	
Stock on hand—		
Value of manure ... implements ... hay ...	£1,843 1s. 0d.	£30,885 17s. 2d.
Amount received for private work	£6,168 5s. 8d.	
Balance from general assessment	£1,873 5s. 9d.	
Leaving as the total cost to the City		£10,843 6s. 4d.

The works for the supply of water to Glasgow are one of the most extraordinary instances of successful engineering on record.

In the words of Mr. Gale, for whose very valuable report on the Loch Katrine works I am indebted to the Secretary of the Institute of Engineers in Scotland:—

"In the face of doubts and distrusts freely expressed, and of unparalleled difficulties arising from the wild and rugged nature of the district through which the aqueduct passed,

the whole works, involving an outlay of upwards of £900,000, and extending over 34 miles of country, were completed in less than 4 years. It is a work which will bear comparison with the most extensive aqueducts in the World, not excluding those of ancient Rome; and it is one of which any City may well be proud."

It would be impossible in a sketch of this kind, to give even a bare outline of this gigantic work. I may, however, briefly notice from the above report that the gathering ground of the Loch Katrine works, made by damming up Loch Katrine, Loch Vennacher, and Loch Drunkie, covers about 45,800 acres.

The aqueduct from the Lochs convey the water to a service reservoir, 25 miles from Loch Katrine. This reservoir has a water surface of 60 acres, and a depth when full of 50ft, and containing 548,000,000 gallons, and is 317ft. above ordnance datum.

The water is drawn from the reservoir by pipes, and about 50 yards from it passes into a circular well cut out of the rock, 40ft. diameter and 63ft. deep, and is strained by passing through copper wire cloth, 40 meshes to the inch, arranged in oak frames, forming an inner well of octagonal shape, 25ft. diameter, and from this latter the water finally passes into 2 lines of pipes leading to the City. These 2 pipes are 42in. in diameter, and are intended to deliver the whole 50,000,000 gallons a day. They first pass through a tunnel, 440 yards long, and then diminished in size to 36in. are continued for a distance of about 7 miles to the City.

Water is also supplied to the City from the Gorbals water works, which draw their supply from the Brock Burn, a small stream having its sources near Brother Loch and Long Loch, in the south east of Renfrewshire. The surface water is collected in 4 reservoirs, and after being filtered, is supplied to the City by gravitation. The lowest reservoir is $4\frac{3}{4}$ miles from the upper sources of the stream, and about 6 miles from Glasgow.

In connection with these reservoirs, there are 2 distributing tanks, and 2 sets of filters. Each set can be worked while the other is under repair. Each set of filters is divided into 3 transverse sections, any one of which can be cleared without stopping the action of the others. The filters are upon the Lancashire principle, the sand being removed when foul, washed, and again replaced. When any filter has ceased to discharge its proper quantity of water, about 1in. of sand is removed, and a new filtering surface exposed. The sand is washed by an upward current of water in cast iron boxes.

The area of the filtering surface is 3,800 square yards; and the average quantity of water passed through is 875 gallons a square yard per 24 hours.

The 2 tanks into which the water passes from the filters are each 220ft. long, 66ft. broad, and 19ft. deep. They contain 3,250,000 gallons, and are 240ft. above ordnance datum when full.

The main pipe to the Town, 24in. in diameter, passes from these tanks, the inlets being furnished with valves, and copper wire cloth strainers. The average daily supply of water furnished by the Commissioners during 1868 was obtained thus—

From Loch Katrine,	22,100,000 gallons.
From Gorbal's gravitation works,	3,730,000 „
Total	26,830,000 „

The domestic rate is 1s. in the pound over the whole municipality, and 1s. 1d. in the northern suburbs, together with 1d. of public rate chargeable to the owners of property within the municipality.

So abundant has the supply been, that the Commissioners have been enabled to furnish some of the neighbouring Towns, such as Renfrew, Pollokshaws, Rutherglen, etc.

In houses at the higher levels, cisterns are compulsory, but not elsewhere, except for water-closets, although many water-closets are supplied direct from the mains: single valve cisterns are used for water-closets. The house taps most commonly used are the common ground cocks which cause great waste.

SWANSEA.

The following Statement has been compiled partly from extracts taken from the very valuable report of E. DAVIES, ESQ., Medical Officer of Health, and from information kindly placed at my disposal by E COUSENS, ESQ., the Borough Surveyor. Extracts have also been made from the Municipal Corporations' Directory.

Swansea is a Borough situated on the west side of the river Tawy, at its mouth at Swansea Bay in the Bristol Channel. The Town has communication with the South Wales and Vale of Neath Railway, and with the South Wales and Swansea Vale Railway. It has also water communication with its own and adjacent counties by means of the river Tawy, the Swansea and Neath canal, and another canal which runs up the valley for a distance of 16 miles.

The staple trade of Swansea is the smelting and refining of copper, which is brought hither for that purpose from all parts of the world. There are also iron, tinplate, zinc, patent fuel, and alkali manufactories. The exports consist of the articles manufactured here, and the imports of metallic ores, timber, tobacco, hemp. tallow, flour, grain, etc.

Population in 1861, 41,606; in 1869 estimated about 60,000; inhabited houses, 8,778; gross estimated rental, £131,375; rateable value, £123,000; area of Borough, 4,363 acres.

FROM DR. DAVIES' REPORT :—

"Previous to 1857 Swansea was without a system of drainage, at that time there was only one main sewer along the Strand which emptied itself into the river, receiving in its course the contents of the Old Town ditch, partly surface water, and partly sewage from the lower part of the Town.

The Town ditch was in fact an open sewer along a great part of its course, from 3 to 4ft. wide and in some places 5ft. deep; always stagnant, and in summer weather offensive and dangerous to the public health. The cesspool system was general, and the water supply of that part of the Town above the level of the existing reservoir which was obtained from pumps and wells, was insufficient in quantity, and in many instances of a very questionable character.

In 1857 the main drainage of the Town was commenced. There are 5½ miles of brick sewers and 34 miles of pipe sewers.

The system of sewage adopted in Swansea differs in some respects from that of many other Towns and is believed to have advantages peculiar to itself.

The main outlet sewers constructed of brick are eggshaped in section, varying from 4ft. by 3ft. to 2ft. 3in. by 1ft. 6in., with other mains of circular glazed earthenware pipes, from 18in to 9in. in diameter. Except in the case of cellars abutting on the sewers, houses are not drained directly into the main sewer but into subordinate sewers at the rear of the houses on both sides of the street. In this way, with the precautions immediately to be mentioned, the risk of the escape of sewer gas into the interior of houses is avoided, and the expense of private drainage is very much lessened.

The sewers are easy of access, and the drainage of back premises is not carried under the houses. Each house is connected separately with the subordinate sewer, which is finally connected with the main sewer at the end of the street.

Ventilating shafts are constructed in connection with every manhole along the course of the main sewers at an average distance of 40 yards from each other, and before the gases escape into the street they must pass through trays filled with finely broken vegetable charcoal. The result is most satisfactory, the neighbourhood of the ventilators is not offensive, and as a proof of the efficiency of the ventilation it may be mentioned, that it is at all times possible to enter the sewers

for the purpose of examination and repairs, and the effluvium is never so concentrated as to be overpoweringly offensive to the workmen.

In order still further to protect the interior of houses from danger arising from sewer gas, a double system of traps is provided ; the drainage of closets and sinks within houses is not carried direct into the sewer but the pipes from these places discharge themselves into trapped gullies outside the houses, and above the point of discharge there is a communication with the water-shoot, which acts as a ventilating shaft.

The flushing of the sewers is effected in two ways :—

1st.—Where the highest point of the sewer adjoins the street and is easily accessible, the sewers are flushed by means of a hose attached to the hydrant on the water main.

2nd.—Where the sewers can only be reached through houses they are flushed by self-acting flushing chambers, which act at intervals of from 4 days to a week.

The action of the flushing chambers is shortly this,—a receptacle balanced on an eccentric axis is gradually filled with water, which, when it reaches a certain height in the receptacle representing a quantity of about 150 gallons is suddenly discharged into the sewer, the receptacle immediately returning to its place to be in course of time refilled."

The main drainage cost £47,000.

The Water Supply is obtained from a reservoir capable of holding 300,000,000 gallons, formed by an embankment thrown across the valley of the Lliw river. The reservoir is situated among the hills about 9 miles away from the Town, and the river receives the rainfall of about 1,860 acres, principally common lands, and is entirely free from any possibility of sewage contamination.

The water flows through earthenware conduits, 2ft. in diameter, from the storage reservoir into the Borough and is distributed within the Borough by about 20 miles of iron pipes, varying in size from 2ft. to 2in. in diameter. About 7,000 houses are connected, and the water-closets are fitted with cisterns, but for other purposes the water is drawn direct from the mains.

The supply is on the constant system, excepting during a short time in summer when it is necessary to shut the water off for a few hours during the day.

Dr. Davies says also—"That there is every reason to believe that the sanitary improvement of the district is really beginning to tell on the public health, and the reduced death rate of 1867. viz.,—18.1 per 1,000, against 28 of the previous year, and 24.1 of the 3 years preceeding, is an augury of better things and is an indication that Swansea is about to place herself in a position, which, from her natural position, she ought to occupy among the healthiest Towns in the Kingdom."

PORTSMOUTH.

The following Statement is compiled from information kindly supplied me by S. E. Greatorex, Esq., Borough Engineer, and from the Secretary of the Water Company.

Portsmouth, together with Portsea Town (included in the borough) is situated on the Island of Portsea, which is 15 miles in circumference.

Population estimated at 115,000; inhabited houses, about 20,000; the area sewered covers 2,374 acres; rateable value £253,941 15s. The sewage is removed both by pumping and by gravitation. The area of the Town from which the sewage is pumped covers 740 acres: of this, half is densely populated, the remainder is suburban.

The high level sewer removes by gravitation the sewage over 1,634 acres, half of which is already, and the other half is rapidly becoming, densely built upon.

The sole of the sewers in the low level, or the area pumped, ranges from 3ft. to 4ft. below high water mark, to 6ft. and 8ft. above it. The outfall is into the sea, and is about 18in. below low water mark. The mouth of the outfall is laid 5ft. below ordnance datum.

The outfall is situated in Langston Channel, where the tide runs out about 7 knots an hour.

From the pumping area the rainfall is excluded as much as possible; but the higher level carries off both storm water and sewage.

The main sewers are eggshaped and constructed of brick; at their upper end they are 3ft. by 2ft., running into 4ft. by 2ft. 8in., 4ft. barrel.

The low level empties into an elliptical sewer, 5ft. by 3ft. 8in., from whence it is pumped into the outfall, whence it is conveyed into the sea by 2 iron pipes, each 3ft. in diameter.

The branch drains are partly brick, partly stoneware pipes.

The brick drains are all eggshaped and vary in size from 1ft. 9in. by 1ft. 2in. to 2ft. by 1ft. 4in.—2ft. 6in. by 1ft. 8in.—3ft. by 2ft. These are all laid into stoneware blocks (JENNING'S patent.)

The stoneware pipes are vitrified and vary in size from 12in. of 1⅛in. thickness, to 15in. of 1¼in. thickness.

The sockets are 2½in. deep, and they are laid and embedded in 4in. of concrete all round. There are manholes at distances of about 300ft., and flushing shafts at every bend; and the sewers are ventilated through charcoal trays.

The soil pipes from water-closets are 6in. and 9in. diameter.

The main drainage works are estimated to cost £150,000.

The water works are in the hands of a private Company. The supply is intermittent, and is on for about 8 hours out of the 24. It is derived from spring water in the chalk at Havant, about 8 miles distant from Portsmouth. The water flows into a collecting reservoir, which holds about 2 million gallons, from whence it gravitates into a pumping well, from which it is lifted by 2 80-horse power engines into a service reservoir in Portsdown Hill, situated about 2½ miles from Havant, whence it is brought into Portsmouth, a distance of about 7 miles.

The supply equals about 3 million gallons a day, and is distributed to about 16,000 houses. Cisterns in houses are compulsory.

WORTHING.

The following Statement is compiled from information kindly given by the Local Authorities.

Worthing is a small Town, on the coast of Sussex, chiefly noted as a watering place. The lowest part of the Town is from 3 to 4ft. below high water mark.

The population is estimated Nov. (1869), to be between 7,000 and 8,000 persons. Therea of the district sewered, comprises 2 square miles.

Main drainage works have been executed, and a separate system adopted. The main sewers constructed of brick, are barrel shaped, they are 3 ft. at the outfall, diminishing gradually to 12in. at the highest point.

The branch sewers are glazed earthenware pipes, from 6in. to 9in. diameter. There are about 1,500 houses fitted with water-closets. Ventilation is effected through charcoal trays at the manholes, and also through 6in. ventilating pipes. The down spouts are not connected with the sewers.

Flushing is effected by hose pipes, connected with the water mains, at the bend of every sewer.

The sewage flows down to a well, which is 30 ft. deep, and of an average breadth of 10 ft.

In dry weather about 400,000 gallons, and in wet weather double the quantity is pumped by 2 engines 1 of 16 horse-power, which works an average for 18 hours, 1 of 20 horse-power, which is only occasionally used.

There are 2 pipes, through which the sewage is conducted from the pumping well; one of earthenware, 15in. in diameter, for conveyance of sewage for the low level; the other of iron, through which the sewage is forced on to the high level.

The Sewage Farm at Worthing consists of 90 acres, which slope downward to a brook. The sewage for the low-lying ground, brought down as described above, is received into a cistern on the highest level; from this it flows through a covered main carrier, consisting of a pipe about 1 ft. in diameter. Branch carriers which are simply earth trenches, communicate with the main carrier, and are distant from each other about 3 rods (49½ ft.) At each junction with the main, is an expensive and unnecessary arrangement, consisting of an iron flanged pipe let into masonry.

One field consisting of 40 acres, is sown with rye grass. Up to September, 4 crops had been cut, averaging 12 tons per acre.

Twenty-seven acres were laid out in pasture, on which cattle were grazing.

On the high level there are 20 acres on to which the sewage is pumped; 9 acres being sown with rye grass, and 11 with roots and cabbage.

Mr. Langley the able superintendent of this farm, advises that the land should be divided into 3 portions, and that in the early autumn of each year it should be all ploughed, and the land soaked with sewage for a fortnight.

Then, that the 1st division should be sown with roots, the 2nd with cereals, such as wheat, oats, etc.; and the 3rd with rye grass.

By such treatment a succession of crops is ensured to each plot of land, and the soil will yield far heavier crops, than if the same crop is repeatedly grown on the same land.

HASTINGS.

The following Statement is compiled from information kindly given me by J. Meadows, Esq., Town Clerk; and from extracts from a report by Wm. Andrews, Esq., Borough Surveyor; and also from extracts taken from the Municipal Corporations' Directory.

The Old Town of Hastings is situated in a valley between 2 hills, whilst the New Town extends along the sea shore, until it becomes incorporated with the township of St. Leonards.

The population of Hastings is estimated to amount to about 30,000, who live in about 4,000 houses; the gross estimated rental is about 20 per cent more than the rateable value, which is £162,836; the area of the Borough is 1,800 acres.

Main drainage works have been executed at a cost of £47,030.

Formerly the sewers discharged into the sea by 3 outlets, but the sewage formed a nuisance on the beach, and an intercepting sewer was consequently begun in 1866 and finished in 1869; the old outlets being still retained as overflows during storms. The sewers carry off both storm water and sewage: they extend for about 12 miles. The main sewers are constructed of brick and are eggshaped, while the subsidiary drains are stoneware pipes, and they vary in size from 9in. to 5ft.

The main intercepting sewer from Warwick Square to the Albert Memorial, a distance of about ¾ of a mile, is 2ft. 9in. by 4ft., with an inclination of 1ft. in 794ft.; from the Memorial to the junction of the Bourne, being a length of 1 mile 200ft., the sewer is 3ft. 6in. by 5ft., and has an inclination of 1ft. in 1,320ft. From the

Bourne to the tank the length is ¼ of a mile, and the sewer 4ft. by 5ft., with an inclination of 1ft. in 1,320ft.

The sewers are ventilated into the streets through charcoal trays; and they are flushed by salt water, which is impounded at high tide, and allowed to flow through the sewers.

The sewage flows into a tank 210ft. long, by 100ft. broad, and of a depth of 14ft.: this tank is capable of containing 1½ million gallons. The bottom of the tank is about 5ft. 6in. above low water at neap tides. Its discharge pipe is a cast iron 4ft. pipe, with a fall of from 8 to 10ft. per mile, which will empty the tank when full in about 1½ hour. The penstock is lifted about an hour before low tide, and the sewage runs away to the eastward.

The Water Supply of Hastings is derived from surface reservoirs, from springs, and from an artesian well.

The water after collection is forced by pumps up to tanks, about 400ft. above sea level, and about ½-mile from the pumps. The supply is intermittent; and cisterns are compulsory on houses.

A controversy arose some few years ago, regarding the contamination of the water with lead, and it was stated that instances of lead poisoning had taken place in consequence of drinking the water that had been stored in leaden cisterns. An analysis of the water so used was made by Dr. Taylor, who failed to detect any appreciable quantity of lead in the water.

CROYDON.

The following Statement has been compiled from extracts from the very valuable reports of Baldwin Latham, Esq., Engineer to the Local Board of Health.

"The Town is situated in the county of Surrey, on the east and west sides of a valley through which the river Wandle runs,

The natural drainage outfalls of the Parish are—for the north portion into the Effra river; for the north-east portion into the Ravensbourne; for the north-west and centre portion into the Streatham brook; and the remaining portion into the Wandle. The total area of the district under the jurisdiction of the Local Board is 9,821 acres; and the population is estimated at 70,000.

Croydon was almost the first town to put in active operation the Public Health Act, and to try the new system of tubular pipe sewers, although it was a system condemned by some of the ablest Engineers of the day. In spite, however, of that condemnation, it is a system that has year by year gained extended adoption, and has completely revolutionized the whole system of drainage throughout the Country.

As Croydon was the pioneer in the track in which many Towns have followed, many imperfections did of necessity exist in the early works. Of the great errors committed in the early works, one was the too small size of some of the sewers; and another the want of sufficient strength in the sewer pipes themselves, 15in. pipes having a thickness of but ⅛ of an inch. collapsed when laid at moderate depths.

The total absence of any system of ventilation of the sewers was the most grievous error, for no sooner was the original works drawing near to completion, than the Town was visited by an epidemic of Fever, which though not very fatal, was extensively prevalent. There can be no doubt that this outbreak was due to the entire absence of any system of sewer ventilation. A remedy against the recurrence of such a disaster was at the time proposed, and a system then adopted; but within the last 18 months, a more perfect system of ventilation has been devised and carried out. The Board have now under their control 75 miles of public sewers, of various sizes and inclinations and depths.

The sewage is removed at the outfall into 1 of 2 large settling tanks, where it is strained to remove the solid matter, which, after being mixed with street sweepings or earth and allowed to stand for a few days until quite solid and free from odour, is used on the land. The liquid portion of the sewage then flows on to the Farm at Beddington, which is situated about 2 miles from the Town, and covers 280 acres. The soil at Beddington is sandy upon a gravel subsoil. The sewage flows through open earth channels; the main channel varying in breadth from about 12ft to 4ft. The land is laid out in Italian rye grass, and common English grasses. Earth trenches communicate with the main channel, at distances varying from 15 to 20 yards apart.

"The sewage"—Mr. Latham says—"may be applied during all stages of the growth of the plant, up to the time of cutting the crop; and it only need be withdrawn from the land for a very limited period previous to the time of cutting."

In carrying out this system it is absolutely necessary to prepare the land for the reception of the sewage, by carefully levelling it, so that no holes or uneven places may exist: an uneven place will certainly retard the flow of the sewage, and if the sewage should be allowed to stagnate, owing to any uneveness in the ground, it will effectually destroy instead of invigorating the crop.

The sewage of Croydon varies (1866) in bulk from 50 to 120 gallons per head per day of the population.

About 6 crops of grass have been cut in a single year, and sold for an average price of £5 per acre.

The effluent water flows into the Wandle.

Italian rye grass is the proper crop for sewage, but it dies out every 3 years, and it requires to be renewed *after*—and this is the first principle in sewage irrigation—the land has been ploughed up.

The Water Supply of Croydon is derived from 3 wells, sunk and bored into the chalk.

The original works for water supply consisted in enlarging and deepening a well on the site of the works.

The erection of 2 Cornish engines, with cast iron equal beams, 30in. cylinders, and 9ft. stroke, the plunger of each pump being 12in. in diameter. The erection of 2 single flued Cornish boilers, 5ft. diameter, and 21ft. long, which very shortly after the completion of the works, were supplemented by another boiler of the same dimensions, and the construction of a covered reservoir at Park Hill, consisting of a domed chamber, 74ft. diameter, and 35ft. deep, capable of holding 900,000 gallons of water.

A rising main 12in. in diameter was laid from the works to the reservoir: this main also furnished the supply of water to the Town.

The original works were calculated to furnish a supply of 1 million gallons of water per day; and their cost amounted to £26,353 14s. 8d.

The rapid increase in the population of the Town, and the consequent increase in the consumption of the water, rendered it expedient to provide the means of furnishing an additional supply.

A new well was sunk and bored to the depth of 150ft., being just twice the depth of the old well. Upon the completion of this well, it was found to furnish a supply of water totally independent of, and distinct from the supply of the old well.

The site of the new well was arranged to form the pumping wells, in which the pumps of a large engine could be fixed, and as it was found on the completion of the well that there was no connection between the supplies of water,

it became necessary in order that the engine should raise the full volume of water, that a connection should be made between the new and old wells.

This was done by means of an 18in. cast iron syphon, which performs its work admirably; provision is made in the machinery for keeping this syphon exhausted of air.

A new engine which is in the same house as the old one has been erected. It is a Cornish engine, and has a wrought iron beam, consisting of two rolled 1½in. plates, kept apart by cast iron distance pieces which are rivetted to the plates. The beam is 38ft. long over all 35ft. from centre to centre; the piston and pumps have each 10ft. 6in. stroke; the plunger of the pump is 24in. diameter, and the cylinder is 60in. diameter; the cylinder is provided with a steam jacket, and this again is felted and lagged; the piston of the engine is supplied with metallic packing. Instead of the ordinary injection condenser, a surface condenser containing about 400 copper tubes has been fitted to the engine. The advantages of this description of condenser are, that the water passing into the condenser to condense the steam never comes in actual contact with the water required for condensing, consequently the water passing away is as pure as when introduced, and not being at all contaminated with any oily or any other matter, as in the case with the injection condensers of the old engines, it is at once available for the public baths, and now supplies the swimming bath with warm water.

These new boilers, each 27ft. long and 5ft. 6in. diameter, and each containing a single tube 3ft. diameter, have been fixed. The furnaces of these boilers are fitted with smoke consuming apparatus.

An 18in. rising main has been laid from the new engine to the reservoir, and base of the water tower at Park Hill: 23¼ miles of water mains have been laid in connection with the new works.

The erection of residences in the higher parts of the Parish rendered it necessary to establish a high level service, consisting of water tower engine, and engine house, and a distinct set of mains to these high districts.

The water tower contains a reservoir in the base which will hold 94,000 gallons of water, and which is on the same level as the covered reservoir in connection with the supply of the Town; also a summit tank of wrought iron capable of holding 40,000 gallons of water. The shell of this tank is made of ¼in. plates of iron, strengthened at the joints with T irons, and the bottom of ⅜ plates. It is supported, partly on the external walls, and partly on 3 central columns, one of which serves to furnish a supply to the high level, a second forms the rising main for the engine house, and the third acts as an overflow.

The engine house is situated at the foot of the Tower, and contains an horizontal engine and 2 double-acting pumps, fixed vertically: the steam is furnished by 2 of FIELD'S vertical boilers.

The new water works, including all the mains, cost of water Tower, low and high level engines, pumps, engine houses, boiler houses, monies paid for compensation, and a stock of pipes in hand has been £42,430 0s. 7d.

At the present time (Sep. 1869), 7,697 houses are supplied, and the supply is distributed by 11,005 taps, 9,416 water-closets, 284 baths, and 27 fountains. The population supplied in 1868 and 1869 may be taken at 45,000 persons, and the quantity supplied at 50 gallons per head per day. The average daily supply has been 2½ million gallons; but from defective service pipes, there has been and is an enormous leakage, so that it is estimated nearly 1½ million gallons are daily lost or illegitimately used."

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